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ART. I.—*Notes and Remarks connected with Meteorology on Lake Superior, and on the variations in its level by barometric causes, and variations in the season;* by WM. W. MATHER, Professor of Natural Science in Ohio University.

THE author of this paper has spent three summers and parts of the autumns, on Lake Superior, exploring the coasts, and examining mines in operation besides undeveloped veins of ore. Some meteorological observations were at the same time made, that may not be unacceptable to the scientific public.

During June and a part of the month of July, the weather is generally serene, with a clear sky, and little rain except occasional thunder-showers. The lake is calm, and this is the most favorable season of the year for coasting in boats and canoes. The prevalent winds during the summer are from the west and s.w. Many parts of the lake even in this calm season of the year, are subject to sudden squalls. The Indians and voyageurs are very cautious; but many persons unacquainted with the coast and the local land blasts, frequently expose themselves to great peril. These land blasts are often violent when nothing is seen to indicate their approach. Some of the voyageurs state that while coasting along with the weather calm or only a gentle breeze, the boat, just before one of these blasts, seems to be suddenly lifted as if struck by some unseen force; and in such cases they at once make a landing. Boats strongly manned cannot always make headway against these sudden squalls, and frequently they are driven off the land.

There are some localities where these blasts are frequent. At Sand Bay, as it is called—a mere indentation or bight of the coast

between Eagle Harbor and Eagle River, four or five miles across at its capes—puffs and blasts of warm air from the land are common, especially in the afternoon and evening. The land rises very gradually from the coast for one half to one mile, and then rapidly ascends to the height of the mountain eight hundred to twelve hundred feet, and this range of hills extends for many miles with nearly uniform surface and height, rarely broken by ravines. The wind often blows strongly from the land for many hours. The same facts have been observed at Porter's Island and at Copper Harbor; both open to the north on the lake, and both have similar ranges of high land on the south.

At Bete Gris Bay on the southern side of Kewena Peninsula, a range of mountains eight hundred to thirteen hundred feet high, bounds the north shore of the bay and extends many miles to the west, gradually curving around to the w.s.w. and s.w.; and a flat country skirts the bay on the south and west, and extends thirty or forty miles to the s.w. between the mountains and the south coast of the peninsula, with a breadth of four to eight miles. Violent blasts of warm air often blow from the west out of this bay in the afternoon. The bay opens to the S.E.

In Yellow Dog Bay at the mouth of Yellow Dog River, similar facts have been observed. This bay opens to the N.E. While it was calm at the capes of the bay and on the lake, a strong blast of warm air from the land blew from the s.w. out of the middle of the bay; and between this axis and the capes, the air blew in towards the axis, converging towards a point outside the bay in the lake. Such facts are common in calm weather when the sun shines brightly. Similar observations have been made in many places, and they are here noticed because they seem to be in opposition to the generally received notions of the action of the sun and heated air in a hilly and mountainous region. These phenomena often extend into and through the night. The theory of the land breeze explains it for the night, but not for the day.

Notes in regard to the weather and barometric waves on Lake Superior, 1846.

The following memoranda from my diary, are introduced with a view not only to shew the general character of the weather on the lake coast, but also to shew some of the facts from which the inference is drawn that the sudden fluctuations of level of the water on the lake coast, generally precede gusts or storms. The aurora borealis has long been considered a precursor of gales. In the meteorological register annexed, some observations of greater exactness are registered bearing on these points.

June 9. On Lake Superior, between White Fish Point and Manito Island; calm, occasionally a light s.w. wind; fog banks at a distance through the day, appearing like distant land.

10 to 15. Pleasant weather; nothing noted in diary.

15. Rain last night and cloudy morning; wind east by north; cleared off at 10 A.M.

16 to 25. Pleasant weather; nothing noted in diary.

25. Wet stormy morning and fog till 11 A.M. at Salmon Trout River; cleared at 12; calm.

26 to July 1. Pleasant hot weather; in Ontonagon region.

July 1. Pleasant hot weather; on the west branch of the Ontonagon.

2. Thunder in morning, and succession of heavy thunder showers all day; twenty miles south of Lake Superior, on the west branch of the Ontonagon.

3 to 9. Pleasant weather and very warm; exploring as above, and returning to the mouth of the Ontonagon, and coasting to Iron River.

9. Wind strong from the west until 3 P.M.; then calm and very warm; heavy thunder shower and very vivid lightning in the evening, in the direction of Thunder Cape, north, and Thunder Bay, where almost every evening after a pleasant calm day in summer, a thunder cloud may be observed.

10. Calm in the morning; coasting west till 9 A.M., when the heavy west wind obliged us to land; calm at evening.

11. Surf heavy on shore from a blow in the N.W. last night, when there was a heavy thunder gust. Pleasant day; wind eastward till 3 P.M., when it came around to the west.

12. At Iron River, pleasant day; wind in the morning strong from the east.

13. Strong current set into the river this morning early. Heavy wind at sea from the west at 5 A.M. Embarked with boat sail reefed, carried away main sheet and broke rudder. Wind hauled from the west at 6¼ A.M. to N.E. blowing a gale, but we were enabled with great difficulty, and danger of swamping on the bar of the Ontonagon, to enter that harbor. After 10, cleared off hot and sultry; cold evening and had a fire before my tent door at Mendenhalls mines; musquetoes in myriads.

14. Pleasant, calm day, except the land blasts which were observed on the Ontonagon River as hot blasts of air, now from one point and then from another. Calm, except occasional hot puffs and blasts from the shore of the lake when off the re-enterings of the coast; went to Misery River.

15. Calm and pleasant, except warm puffs of air off shore as yesterday.

16. Same as yesterday, except that on arriving within a few miles of Copper Harbor where the woods were extensively on fire, momentary hot blasts of air were often felt, and the air was so thick with smoke that rocks could not be seen at three times the boat's length. In the evening and day, there was a steady heavy

blast from the land, and large flakes of fire from the burning forest were carried entirely across Lake Fanny Hooe, so that it was with great difficulty the buildings at Fort Wilkins, half a mile off, could be preserved from the fire.

17 to 28. At Presque Isle, eighty miles south by east of Kewena Point. A rise and fall of the waters of the lake were observed in the bay, and the captain of the Schooner Swallow consequently looked for a blow, though the weather was pleasant and calm, excepting a slight off shore breeze. The vessel sailed at 4 P.M., but in the night a severe blow came from the north and lasted two days, and the vessel with difficulty was kept off the shore.

28, 29. Rainy part of the day, but without heavy wind at Presque Isle; the wind was from the south. A heavy gale and severe rain set in in the night from N.E., and continued till next (30th) morning, when the waves were from fifteen to twenty feet in perpendicular height.

31 to Aug. 7. Weather pleasant but very warm, except on the lake shore, where the cold waters temper the heat. There was little wind, except warm puffs and blasts from the shore during the middle and latter parts of the day, off the reëntering of the coast. During these days I was coasting between Presque Isle and Huron River, encamped on the shore, or exploring in the interior from five to ten miles from the coast.

On the evening of the 6th, at the mouth of Huron River, the water flowed rapidly into the mouth of the river for fifteen minutes, and was raised twelve to sixteen inches above the usual level, after which it flowed out until it reached the usual level.

Aug. 7. Similar variations in the level of the lake and river, were observed in the morning. Severe thunder-showers from N.W. succeeded, with very strong winds, uprooting trees.

8. Heavy thunder-gusts and showers through the night, and forenoon of to-day.

9. Pleasant day; wind east at six in the afternoon; another rise in the water of the lake of eighteen inches, and a sudden fall again in fifteen or twenty minutes, about 1 P.M. Heavy thunder-gust and some rain at 4 P.M. Strong N.W. wind (7 to 9) all night, with some rain. Trees uprooted by the gale.

10. Pleasant day; wind strong from east in afternoon; calm in evening.

11. Pleasant day; calm till 8 A.M; wind south out of Huron Bay at 8½; N.W. 5, at Point Abbaye, 9 to 10 A.M.; calm at 10; south on the side of Kewena Bay at 10½ A.M., and S.W. 4, near Traverse Island. Sailed from the middle of Kewenaw Bay, with this wind constantly increasing in force till evening, when I reached Bete Gris Bay, and landed with difficulty through the surf, although the wind there blew off shore, and the waves

came in to the bottom of the bay at an angle of about 110°, different from the direction in which they rolled outside the bay.

12. Rained hard in the night, with strong wind from the east, and this morning from east and S.E., and thence hauled to N.N.W., and finally in the afternoon to S.W. Started this afternoon to go west from Bete Gris Bay to the west end of Lac la Belle; but the wind blew so hard from W.S.W., that this little lake of two and a half miles in length was a sheet of foam. A strongly manned boat was at times unable to stem the wind in the outlet, and on going into the lake, was half filled with water by the waves in a few moments, and the excursion was abandoned for that day. At sunset it was calm.

13. Calm in the morning at Bete Gris Bay. At 11 A.M. the wind began to blow out from Lac la Belle as yesterday, and increased in violence till 4 P.M., after which it abated gradually. To-day at 3 P.M., a well manned boat could not head the wind and sea in this little sheet of water, and make any progress. At 7 P.M. it was calm. This W.S.W. wind flowing out to the open lake from along the base of the mountains, is very common in the afternoon of warm pleasant days in summer.

14. Loons were very vociferous between 2 A.M. and daylight. This is generally considered by voyageurs as an indication of strong winds, or of approaching storms. I aroused my men before day, and embarked for Copper Harbor. The air was clear and calm till 8 A.M. Wind then from S. 2, towards the land; at 9 A.M., S.S.E. 5, near the southeast point of Kewena Peninsula; at 10 A.M., S. 3, at the east end of that peninsula, with frequent strong blasts off shore from the west, of warm air; 11 A.M. till 2 P.M. on north side of the peninsula, a dead calm, except occasional puffs of warm air from the land; from 2 P.M. the wind blew very strong from the west all night.

15, 16. Stormed all day, wind and sea heavy from the west.

17. Pleasant, but wind and sea heavy from the west.

18. Stormed all day.

19. Stormed till noon, with heavy west wind, then clear and calm. Embarked at 4 P.M. for the Portage, but heavy squall and dense fog from west forced us to land at 4½ P.M. Stormed and blew strongly from N.W. all night.

20. Very heavy surf on shore: could not pass the breakers. Calm. Sea calmed down enough to pass the breakers on the deep part of the reef at 1 P.M., but lake still too rough to travel in safety even in a fine whale boat.

21. Pleasant, warm day; little wind, except occasional warm blasts from south, off the land.

22. Wind and sea heavy from west till 12 M., when it hauled suddenly to east. Went from Eagle River to near the Portage.

23 to 26. Pleasant, fine weather; wind not noted.

26. Rain last night and this morning; pleasant afternoon.

27. Pleasant day; wind west and N.W. 3; calm in evening.

28. Pleasant day; wind W. 3; calm in evening.

29. Pleasant day; wind W. 5. Run to Copper Harbor in afternoon, about thirty-five miles.

30 to Sept. 3. Pleasant weather; winds not noted, except on 2d in afternoon, a strong current of water set out of the bay at Copper Harbor, and one of our voyageurs in a light bark canoe came near being driven off the land. A heavy blast of warm air from the land blew at the same time out of the harbor, and the water fell in the Bay about one foot.

Sept. 3, 4. Heavy wind and rain storm from the north, both days.

5. Pleasant, with warm land breeze from the south.

6. Stormy, and strong west wind. Blew violently with heavy rain through last night. Embarked on board steamboat Julia Palmer; but she did not leave harbor in consequence of the violent storm. In the afternoon, blew very heavily and in gusts from the south.

7. Blew a gale with hard rain all night and till noon to-day from the west, and then hauled to N.W. and north, and continued through most of the night with equal force.

8. Pleasant, calm morning and day. Light breeze from S.E. and east. Landed at 10 P.M. at the Ontonagon River. Boat nearly swamped among the breakers at the mouth of the river, and with difficulty recovered the channel.

9. Cloudy and rainy most of the day; N.E. storm. Cleared off in the afternoon. A moderate land breeze with strong puffs of warm air blowing off shore. Water rose suddenly 1½ feet, and in receding carried off some boats. Heavy squall approaching from N.W. At 10½ P.M. the thunder-gust came on, blowing a perfect gale, blowing down the tents, and unroofing a house, and the steamer had great difficulty in keeping off the lee shore. Rain fell in torrents, and the lightning was almost constant. Heavy wind and rain from N.W. and north continued all night.

10. Wind still heavy from north, but otherwise a pleasant day.

11. Pleasant day, but very windy, and lake very rough. Calm evening. Beautiful aurora borealis in the evening; stripes of light of varied colors passing with rapid motion. Calm through the night.

12. Calm, bright, beautiful day. Went to Misery River.

13. Boisterous day, but sun shone. Wind west.

14. Severe thunder-storm last night, and wind through the day from the north and N.W.

15. Pleasant day; wind not noted.

16. Pleasant morning, with strong west wind. Went to the Portage. Voyageurs said we must land—"wind too much."

Nearly swamped the whale boat, in landing in the most sheltered place that could be found on that coast. Wind continued all day till night, when it became calm.

17. Pleasant day; wind west and N.W. 4. Embarked and went to the Cross, near Gratiots River.

18, 19. Pleasant days; wind west. Went to Eagle Harbor. Severe thunder-storm evening of 19th. Heavy wind from north all night.

20. Wind N. 8. Lake a sheet of foam, and very heavy sea.

21. Pleasant; wind not noted.

22. Pleasant; calm in morning. Embarked and went to Agate Harbor. Squalls from every direction in afternoon. Sky looked very threatening, and water oscillated repeatedly a foot in level every half hour, and sometimes more frequently, at Agate Harbor. Blew a gale from the north and N.W. through the night.

23. Lake very rough, and several sets of waves, producing a very cross, chopped sea. Squall clouds in various directions. Embarked, but nearly swamped several times, from the cross seas. Heavy squall came suddenly from N.W. Run into a little boat harbor before it struck us. In a moment the lake was a sheet of foam, and the wind continued blowing heavily from the N.W. all day and night.

24. Pleasant and calm, but lake too rough to pass the breakers on the deeper parts of the reef. In afternoon, embarked and went to Copper Harbor. Strong blasts of warm air from off the land, with intervals of calm.

25. No note of weather.

26. Storm; heavy surf on the shore from N.E.

27. Storm; heavy surf on the shore; wind N.W.

28. Storm; N.E. misty rain.

29. Pleasant day; wind not noted.

30. Pleasant day; wind W.N.W. 6; heavy surf on the shore.

Oct. 1. Stormy day; wind from east, and hauled round to south in the afternoon.

2. Pleasant calm day.

3. Cold stormy day. Embarked on board steamer Julia Palmer, for a voyage along the Canadian shore.

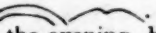
4. Sailed from Copper Harbor. Pleasant; wind moderate from the west in the forenoon, freshened too much for the steamer to head it in the afternoon, and went into Siskowit Bay and anchored. Calm in the evening. This was the first voyage of a steamboat on the north coast of the lake, where there are many unexplored reefs and islands.

5. Sailed from Siskowit Bay at 7 A.M. Calm, but wind soon came from W.S.W., and freshened till 3 P.M., when its force was about 7. Anchored in Prince's Bay, opposite Spar Island, twenty-five miles north of west end of Isle Royal. Shifted to N.E. at 10 P.M.

6. Northeast storm; wind very heavy all night and all day. Low scudding clouds and some rain, and a little snow.

7. Wind N.E. 5; some rain and a little snow; misty thick weather. Sailed from Prince's Bay to mouth of river near Fort William, in Thunder Bay. Clear and calm in the afternoon. Beautiful aurora borealis in the evening; waving stripes of light.

8. Sailed from Point William at $3\frac{1}{2}$ A.M., where it was calm, but at the Welcome Islands, heavy N.E. wind, storm struck us, and continued all day. Steamer battled against the storm and heavy head sea all day to reach the western inlet to Neepigon Bay.

9. Wind blew from the north last night with great violence. Beautiful aurora in the evening. Several arcs visible, one above the other, and an apparent bank of clouds below the two lower ones, but stars visible through it. Arcs variable in height and progressive undulating movements of these arcs, strongly marked like waves, thus  . Almost always in the afternoon and beginning of the evening, before the light of the aurora borealis was observed in the north as a segment of a circle with its highest point in the magnetic meridian.

Long lines and stripes of light of various colors sprung up from the east, and extended entirely over the western horizon and from all points from east around by north to west, and some extended even over to the southern horizon. The crowns of the successive arches were a few degrees east of north, but in the magnetic meridian.

10. Wind blew a gale all day from the east. Water rose so much as to carry away the trestle pier, and create a very strong current to the south from Neepigon Bay to Lake Superior. Wind hauled to south in the evening and blew a gale all night with rain. Strong current from the Lake into Neepigon Bay.

11. Wind S.E., a gale with rain till 12th when the rain ceased but wind did not moderate very much. The air over the main Lake seemed to be clear, but when the masses of air from the Lake reached the mountains of St. Ignace and Fluor Islands, dense black threatening clouds were formed and rolled up and spread over the land with great velocity. This was observed continuing for hours. Steamer weighed anchor and went to a little harbor on the N.W. side of Flour Island. Wind hauled to west at 10 P.M. and blew a heavy gale.

12. Wind hauled to N.W. at daylight, blowing very violently, but gradually moderated. Some hail and sleet last night. Sailed for Sault St. Marie with strong but fair wind from N.W. Pleasant but windy day.

13. Heavy squalls from west and N.W. in night. Arrived at Sault St. Marie. Weather very foggy from White Fish Point, which we passed at 9 A.M. Squalls from north and west. Steamer had to feel her way frequently with the sounding line.

Propeller Independence arrived at Sault St. Marie, Monday evening the 12th, in twenty-five hours from Copper Harbor; she must have had a strong west or N.W. wind all that time.

14. Pleasant time, but cold and gusty.

15. Snow fell last night about two or three inches. Stormy day of rain and some snow. Squalls from N.W. and N.E. Cold uncomfortable weather.

16. Raw, damp, cold, uncomfortable day, cloudy with squalls from N.W. and N.E. Snow fell in the evening and through the night.

17. Raw, cold and boisterous day. Embarked for Detroit.

June 13, 1847. On Lake St. Clair and in St. Clair River. Pleasant weather, but at 1 P.M. heavy squall from the west accompanied by some rain. This had been indicated by black squally looking clouds in the west for an hour. The weather continued squally with dashes of rain through the day and night.

14. On Lake Huron. Heavy gale increasing from daylight till 2 P.M. from N.W. After battling with the storm for hours, the bow occasionally plunging under the heavy waves, the steamer put back and made lee under Point au Barque. At 4 P.M. the wind lulled some and the boat proceeded at 5 P.M., but it was a very tempestuous stormy night. Did not see land on north side of Saginaw Bay till 7 A.M.—fourteen hours going about eighty miles. The gale abated about 8 A.M. but blew hard from W.N.W. and N.W. all day.

15. On N.W. part of Lake Huron between Drummond's Island and Sault St. Marie. Strong west wind all day.

The schooner Merchant is supposed to have foundered on Lake Superior and all on board perished, on the night of the 13th or day of the 14th. She was seen on the afternoon of the 13th forty miles west of White Fish Point, and has never been heard of since. A few fragments were found on the Canada shore.

16. Weather pleasant but windy; course not noted, but westerly, as the Napoleon, which was ready, did not sail.

17. Embarked on the schooner Napoleon for Copper Harbor at 12. Wind fresh from S.E. Opposite Carabou Island at dark, having come one hundred miles since noon, about twelve miles per hour.

18. Wind S.E. and very fresh all night, but died away when opposite Kewenaw Point at 7 A.M. Light breath of air from the south till 9 A.M.; when about to enter Copper Harbor strong east wind with dense fog came off land, and could not see to get into harbor. Wind soon hauled to S.W. Fog blew off at 4 P.M.

19. Weather not noted; strong wind from S.W.

20. Pleasant day; wind not noted.

21. Beautiful calm day.

22. Beautiful calm day; moderate wind from the west.

23, 24. Pleasant weather; wind not noted.

25. Pleasant weather, very fine day; but in the afternoon a breeze came off from the lake, and it became suddenly so cold that a fire was necessary. Strong land breeze off shore in the evening.

26, 27. Pleasant; winds not noted. Generally at this season of the year calm, or with moderate winds during the warmer part of the day, and a land breeze in the evening from S.S.E. at Copper Harbor.

28. Pleasant day; land breeze off shore in the evening.

29. Clear but very windy day; strong wind from the south. Temperature of water on the shore 44° F.

30. Temperature of water on the shore very cold, not noted. Clear day; wind not noted. Probably calm, as I used the artificial horizon without the glass cover.

July 1. Clear day; calm in middle of the day; wind not noted. Used artificial horizon without glass cover with sextant.

2 to 8. Pleasant weather (from recollection, not noted in diary.) Land breeze almost every evening from about 6 P.M. from S.S.E. at Copper Harbor, on Porter's Island.

On the 7th of July, Dr. C. T. Jackson kindly supplied me with a barometer, by means of which a register has been kept to Sept. 6, shewing the barometric pressure, with the temperature, the courses and force of winds, variations in the lake level, &c. The thermometer detached from the barometer, corresponded with the attached thermometer within less than half a degree, and only one is registered except where a fire was made in the room, and then the detached thermometer was removed to the outside of the building with a proper exposure.

During this calm season of the year the surface of the lake water becomes warm, while a little below the surface it is quite cold. The northerly winds, which make the air cold, drive the warm water upon the shore; while the warm land breezes that blow at Copper Harbor almost every day, and often through the night, carry the warm surface water out to sea, and the cold underlying stratum replaces it along the coast. This fact has been frequently observed at Porter's Island during the last summer. Sometimes a change of wind from north to south of a few hours duration, makes a difference of 20° F. in the temperature of the water on the north side of Porter's Island during the calmer period of the summer.

TABLE I.—*Barometrical Register, kept at the Government House on Porter's Island, Lake Superior, from the 8th of July, 1847, to September 6th, 1847.*—Latitude 47° 28′ N. Longitude about 88° W. from Greenwich.

Date.	6 A.M.				9 A.M.				12 M.				3 P.M.				6 P.M.				9 P.M.			
	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att	Th. det.	Winds, &c.	Bar.	Th. att	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.
July 8	29·478	70	.	S.S.E., fresh	29·507	78	.	S.S.E, light.	29·519	79	.	0, calm.	29·466	75	.	0	29·450	71	.	S.E. 2	29·450	68	.	S.E. 4
" 9	·505	70	.	0, calm.	·509	73	.	0	·540	76	.	0, calm.	·479	70½	.	0	·468	74	.	S.S.E. 3	·401	74	.	0
" 10	·470	66	.	0	·491	72	.	0	·476	71	.	0	·460	73	.	0	·429	70	.	0	·412	67	.	0
" 11	·470	69	.	0	·444	70	.	0	·442	76	.	w. light.	·408	74	.	w.	·350	75	.	S.S.E. 3	·351	73	.	S.S.W. 5
" 12	·320	70	.	0	·358	66	.	w. by N. 4	·412	74	.	w. by N. 4	·460	76	.	w. 3	·508	72	.	w. by N. 3	·548	67	.	0, calm.
" 13	·654	65	.	0	·681	66	.	0	·698	69	.	0	·654	64	.	0	·605	68	.	0	·605	70	.	0
" 14	·549	66	.	S.W. 4	·516	70	.	0	·481	74	.	w. by N. 2	·448	73	.	0	·353	73	.	S.S.E. 1	·360	80	.	S.S.E. 1
" 15	·288	72	.	0	·220	77	.	S.E. 3	·214	74	.	N.W. 2	·170	68	.	S. by W. 6	·150	70	.	0	·308	70	.	S.S.W. 1
" 16	·220	70	.	S.W. 2	·160	69	.	S.E. 5	·151	74	.	S.W. 1	·159	73	.	S. by W. 1	·130	72	.	W. 1	·150	72	.	S.S.W. 2
" 17	·320	70	.	S.W. 2	·394	70	.	W. 3	·460	64	.	W. 2, foggy	·480	64	.	W. by N. 1	·530	68	.					
" 18	·500	60	.	N.W. 1	·540	68	.	W. 1	·550	65	.	N.W. 1	·540	68	.	N.W. 1	·510	63	.	N.W. 1	·510	66	.	0
" 19	·460	61	.	S. by W. 3	·450	67	.	S. by W. 3	·438	70	.	N. by W. 1	·368	69	.	W. 1	·348	.	.	S. 4	·340	65	.	S.W. 1
" 20	·230	68	.	S. by E. 1	·320	72	.	W. 2	·300	76	.	S. E. 3	·232	82	.	S.E. 2	·168	80	.	S.E. 4	·170	78	.	S.W. 3
" 21	·100	72	.	W. 1	·101	73	.	W. 6	·174	75	.	W. 6	·220	74	.	W. 5	·240	72	.	W. 4	·290	67	.	W. 4
" 22	·470	60	.	W. 4	·530	64	.	W. 4	·550	68	.	W. 4	·550	70	.	S.S.E. 1	·520	70	.	N.W. 4	·526	68	.	S.S.W. 3
" 23	·550	65	.	S.W. 3	·556	70	.	W. 3	·558	73	.	W. 3	·548	76	.	W. 2	·508	73	.	S.S.W. 3	·430	70	.	S.S.W. 1
" 24	·486	71	.	S.E. ½	·465	73	.	S. by E. 2	·450	76	.	S.W. 1	·371	72	.	S. by W. ½	·328	70	.	0	·281	69	.	0
" 25	·250	66	.	0	·320	62	51	N.W. 1	·416	65	49	N.W. 3	·500	60	48	N.W. 5	·541	62	49	N.W. 4	·587	62	47	0
" 26	·670	56	48	N.W. 1, cl.	·700	62	60	N.W. 1	·710	66	.	W. 1	·690	68	.	W. 1	·680	60	.	W. 1	·670	70	.	0
" 27	·596	57	.	S.W. 1	·630	62	.	S. 2	·600	67	.	S.S.E. 3	·500	68	.	S.E. 4	·440	64	.	S.E. 4	·440	66	.	S.W. 1
" 28	·280	60	.	S.S.W. 4	·264	65	.	S. 5, cldy.	·260	68	.	S. 2, cldy	·224	66	.	0, cloudy.	·169	64	.	0, clear, 5	·132	65	.	S. 3
" 29	28·969	61	.	W. 4	29·000	64	.	W. 5	·032	67	.	W. 6, cirri.	·050	64	.	W. 3, cldy.	·076	62	.	W. 7, st'g.	·099	69	.	W. 7
" 30	29·031	56	.	W. 5, st., r.	·040	64	50	W. 5, r. st.	·050	70	50	W. 5, r. st.	·069	66	.	W. 1, cldy.	·080	70	48	W. 1, storm	·091	68	50	W. 2, st'g.
" 31	·094	55	49	W. 2, st'g.	·170	60	51	W. 3, cldy.	·250	70	.	W. 3, cldy.	·272	67	.	W. 3, clear.	·290	70	55		·331	68	54	0, clear.
Aug. 1	·381	60	56	0	·444	67	57	W. 1	·458	68	62	W. 2	·468	62	62	W. 2	·470	62	62	0, clear.	·500	64	60	clear.
" 2	·540	60	.	0, clear.	·568	64	.	S. 1	·590	69	65	S.S.E. 1, cl.	·570	65	65	E.N.E. 3, cl.	·560	65	65	S. 2, clear.	·550	62	60	S. 5, clear.
" 3	·560	61	.	0, clear.	. .	.	.	E. ½, clear.	. .	.	.	E. ½, clear.	. .	.	.	E. 1.	. .	.	.	S. 2	. .	.	.	0, clear.
" 4	. .	.	.	storming.	. .	.	.	storming.	. .	.	.	storming.	. .	.	.	storming.	. .	.	.	storm.	. .	.	.	storm.
" 5	. .	.	.	. .	. .	.	.	. .	. .	.	.	cloudy.	. .	.	.	clear.	. .	.	.	clear.	. .	.	.	clear.
" 6	. .	.	.	foggy.	. .	.	.	foggy.	. .	.	.	clear.	. .	.	.	clear.	. .	.	.	clear.	. .	.	.	clear.

NOTE.—Cl. stands for *clear*; r. for *rain*; st. for *stormy*; cldy, for *cloudy*.

TABLE I.—(*Continued.*)

Date.	6 A.M.				9 A.M.				12 M.				3 P.M.				6 P.M.				9 P.M.			
	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.	Bar.	Th. att.	Th. det.	Winds, &c.
Aug. 7	. .	.	.	w., clear.	. .	.	.	0, clear.	. .	.	.	0, clear.	. .	.	.	s. 1	. .	.	.	E., cumuli.	. .	.	.	E. 1
" 8	. .	.	.	w. 1, clear.	. .	.	.	E. 2, clear.	29·610	68	.	E. 5, clear.	29·604	70	.	E 4, clear.	29·588	66	.	E. 3, clear.	29·610	68	.	E. 1, clear.
" 9	29·589	64	.	s. 2, floculi	29·610	70	.	s. 3, clear.	·504	74	.	s.by E.3,cl.	·599	74	.	s. by E. 4	·580	70	.	E. by s. 3	·560	66	.	s.by E.4,cl.
" 10	·524	58	.	s.by w.3,cl	·604	74	.	s. 1, clear.	·541	75	.	0	·548	76	.	w. 3	·573	70	.	w. 3	·516	68	.	w. 2, cldy.
" 11	·508	67	.	0, cirri.	·510	66	.	0	·564	69	.	0	·510	60	.	0, clear	·526	68	.	0, clear.	·522	64	.	0, clear.
" 12	·562	65	.	0, clear.	·568	60	.	N. 1.	. .	.	.	N. E. 3	·500	60	.	N.E. 3	·470	60	.	N. 1, clear.	·460	60	.	s. 3
" 13	·294	66	.	s by E. 3	·270	68	.	s. by E.	·250	70	.	0	·240	70	.	w. 1	·294	63	.	w. 1	·338	64	.	0, foggy.
" 14	·318	64	.	s.by w.5,cl	·309	70	.	0, calm.	·330	76	.	w. 5, clear.	·340	76	.	w. 4, clear.	·330	75	.	N.E. 3, cl.	·300	70	.	S.E. 1, cl.
" 15	·341	70	.	s.w. 1, r.	·350	70	.	w.2, clear.	·351	73	.	W.N.W. 3	·350	72	.	0, calm.	·344	68	.	s.by w.1,cl	. .	.	.	
" 16	·330	65	.	0, cloudy.	·326	66	.	0	·314	64	.	E. 1,	·230	63	.	N.W. 6	·300	60	.	N. 4	·330	65	.	W.N.W. 1.
" 17	·320	60	.	w. 5, cldy.	·350	63	.	w. 4, cldy.	·400	62	.	w. 4, cldy.	·480	62	.	w. 4, cldy.	·470	61	.	w. 4, cldy.	·500	60	.	w. 5, cldy.
" 18	·560	58	.	N.W. 5, cl.	·615	67	.	N.W. 5, cl.	·600	67	.	WNW. 5,cl.	·585	64	.	WNW. 5,cl.	·560	60	.	WNW. 4,cl.	·564	60	.	
" 19	·501	58	.	w. 4	·480	65	.	w. 5	·474	67	.	w. 5, clear	·410	71	.	w. 5, clear.	·416	67	.	w. 3	·410	66	.	w. 1, cum.
" 20	·410	65	.	w. 2, clear.	·414	68	.	w. 2, clear.	·400	69	.	w. 3, cirri.	·396	69	.	w. 3, cirri.	·400	67	.	E.S.E. 1, cl.	·401	66	.	0, clear.
" 21	·371	62	.	w. 2, clear.	·380	67	.	w. 5, clear.	·391	69	.	w. 3, clear.	·450	72	.	w. 1, clear.	·459	66	.	0, clear.	·450	66	.	0, clear.
" 22	·550	65	.	0, clear.	·560	66	.	E. 3, clear.	·581	67	.	E.N.E. 3,cl.	·580	67	.	E.N.E. 3,cl.	·560	65	.	E. 2, clear.	·564	62	.	0, clear.
" 23	·640	65	.	s. 1, clear.	·650	69	.	s. 1, clear.	·660	74	.	E. 3, clear.	·628	64	.	E. 4, clear.	·650	64	.	s. by E.3,cl	·650	65	.	s. by E.2,cl
" 24	·701	66	.	0, clear.	·712	68	.	0, clear.	·704	70	.	E. 3, clear.	·672	67	.	E. 4, clear.	·674	66	.	E. 2, clear.	·680	64	.	s. by E.1,cl
" 25	·632	70	.	s. 3, clear.	·610	74	.	S.S.W. 6, cl.	·550	77	.	S.S.E. 5, cir.	·486	80	.	E.S.E. 5,cir.	·400	76	.	S.S.E. 6	·364	76	.	S.S.W. 5
" 26	·300	71	.	s w. 6	·344	68	.	w. 5, rain.	·410	68	.	w. 4	·450	68	.	w. 4, clear.	·474	68	.	w. 3, clear.	·466	69	.	w. 2, clear.
" 27	·350	60	.	S.W. 5, cl.	·300	64	.	w. 7, clear.	·280	67	.	w. 7, clear	·280	77	.	w. 7, cum.	·350	70	52	N. 8, squall	·491	70	48	N. 5, cldy.
" 28	·516	57	49	w. 1, clear	·558	66	52	w. 1	·564	67	55	N.N.W.2,cl.	·530	63	63	N.N.W.2,cl.	·526	70	55	s. 1, clear.	·540	62	48	s. 1, clear.
" 29	·490	54	50	s. by w. 3	·500	59	55	s. by E. 5	·478	64	57	s. by E. 3	·464	72	53	E.N.E. 2	·400	70	53	E.S.E. 3	·386	66	52	E.S.E. 2.
" 30	·420	55	48	N. W. 4	·450	62	56	N.W. 5	·560	66	56	N.W. 5, cl.	·570	61	.	W.N.W. 3	·588	66	56	s.w. 3,cldy	·621	66	60	0, cldy.
" 31	·600	65	58	s. 3,cloudy	·580	68	68	s. 4, clear.	·550	67	.	S.W. 5	·458	65	.	s.w. 4,cldy	·400	66	60	s.w. 4,cldy	·350	62	60	s.w., cldy.
Sept. 1	·250	63	60	w. 3, clear.	·350	66	58	w. 4, cldy.	·380	68	.	0	·330	65	.	w. 1, clear.	·400	60	.	0, clear.	·415	66	.	0, clear.
" 2	·392	57		s. 5.	·360	60		s. 4, r.	·270	74	55	E. 5	·261	68	54	E. 6	·180	67	52	N.E. 7	·178	65	50	N. 7, r. st.
" 3	·500	57		N. 3, clear.	·528	60		N. 3, clear.	·626	63	.	N. 3, clear.	·621	60	.	N.E. 2, cl.	·601	60	54	s. 1, clear.	·630	62	42	0, clear.
" 4	·533	52	48	s. 1, cldy.	·528	61	52	E. 2, cldy	·485	53	.	E. 4, cldy.	·430	52	.	E. 6	·424	53	.	E. 4, cldy.	·415	54	50	E. 4, cldy.
" 5	·320	52	48	S.E. 1, cldy	. .	.	.	E. 1, cldy.	. .	.	.	E. 3, cldy.	. .	.	.	E. 4, cldy.	. .	.	.	E. 5	. .	.	.	E. 5, cldy.

Monthly Averages of Barometer, Thermometer, &c., during the period of observation.

Monthly Averages of Barometer, Thermometer, &c., during the period of observation.

Date.	6 P.M.			9 A.M.			12 M.			3 P.M.			6 P.M.			9 P.M.		
	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.	Bar.	Ther. det.	Winds, &c.
July,	29·331	67	calm 7 days	29·386	66·7	calm 5 days	29·405	69·9	calm 4 days	29·383	69·5	calm 6 days	29·369	67·2	calm 5 days	29·368	67·1	calm 9 days
			W. 5 "			S.E. 4 "			S.E. 2 "			S.E. 3 "			W. 6 "			W. 3 "
			S.W. 7 "			S.W. 1 "			S.W. 2 "			S.W. 3 "			N.W. 3 "			S.W. 3 "
			N.W. 2 "			rain 2 "			S. 1 "			N.W. 2 "			S.S.W. 1 "			S.S.W. 5 "
			S.E. 3 "			W. 9 "			rain 2 "			W. 9 "			S. 2 "			S. 1 "
		64·25	rain 2 "			S. 2 "			W. 9 "			rain 0			S.E. 3 "			S.E. 1 "
						N.W. 3 "			W. by N. 2			fog 0			S.S.E. 3 "			S.S.E. 1 "
						fog 1 "			N.W. 4 d'ys						rain 3 "			rain 1 "
									fog 1 "						fog 0			
Aug.	29·396	61·6	calm 8 "	29·482	65·4	calm 5 "	29·488	67·5	calm 4 "	29·476	67·3	calm 2 "	29·475	64	calm 3 "	29·484	62·6	calm 7 "
			N.W. 2 "			N.W. 2 "			N.W. 2 "			N.W. 2 "			W. 6 "			W. 6 "
			W. 7 "			W. 9 "			W. 10 "			W. 10 "			S.W. 2 "			S.W. 1 "
			S.W. 3 "			S. 8 "			S.W. 1 "			S.W. 1 "			S. 5 "			S. 7 "
			S. 10 "			E. 3 "			S. 3 "			S. 2 "			E. 7 "			E. 3 "
			W. 1 "			rain 4 "			E. 6 "			E. 6 "			N.E. 1 "			N. 1 "
			rain 4 "			fog 4 "			N.E. 1 "			N.E. 1 "			N. 3 "			rain 2 "
			fog 2 "						rain 2 "			rain 2 "			rain 3 "			fog 1 "
									fog 1 "			fog 1 "			fog 1 "			
Sept.	29·399	54	S. 2 "	29·441	57·5	W. 1 "	29·440	59·7	calm 1 "	29·423	57·7	W. 1 "	29·401	54·7	calm 1 "	29·409	47·3	calm 2 "
			S.E. 1 "			S. 1 "			E. 3 "			E. 3 "			N.E. 1 "			E. 2 "
			N. 1 "			E. 2 "			N. 1 "			N. 1 "			S. 1 "			N. 1 "
						N. 1 "						rain 1 "			E. 2 "			
						rain 1 "												

REMARKS.—*July* 9th. 9 A.M., clear, little breeze off on lake: 3 P.M., slight breath to north.—11th. 12 M., wind very light: 3 P.M., wind very light, but a heavy ground swell breaks on shore. Steamboat Julia Palmer passed Harbor at 2 P.M., and returned at 12 P.M. to Copper Harbor.—15th. Vide Table II. Thunder gust. Pleasant, but a violent storm came up suddenly from northwest, 11h. 20m. A.M. Water repeatedly rose and fell in bay two feet, with barometric changes.—16th. 6 P.M., raining gently. Thunder in west, 8 P.M., and rainbow in east.—17th. Steamboat Julia Palmer returned from Fond du Lac.—21st. Sudden fall of water in bay, eight inches at 7h 40m. P.M.—23d. Steamboat Julia Palmer arrived from Sault St. Marie, and left in evening.—25th. 9 A.M., and 12 M., heavy ground swell on lake, rain: 6 P.M., heavy sea, clear. Cold stormy day; fire necessary all day for comfort; water rose and fell in bay by barometric changes.—26th. Frost last night: Propeller arrived from Sault St. Marie.—28th. 6 P.M., clear, clouds in N.W., N. and N.E.: 9 P.M., heavy clouds in N and W.—29th. 6 A.M., cloudy in parts: 9 A.M., cloudy, but sun shines. Very windy and cold stormy day: boats did not venture to cross the bay.—30th. Cold and stormy day; Propeller arrived in twenty-seven hours from Fond du Lac without steaming.—31st. Cold and stormy till noon, after which the sun shone.—*August* 1st. 6 A.M., and 9 A.M., fleecy clouds: 12 M., cirri, some cumuli.—2d. 9 A.M., fog bank. Steamboat J. Palmer arrived from La Pointe.—3d. 3 P.M., clear, cumuli in W.: 6 P.M, cloudy, cumuli in S.W.—4th. Cold stormy day, and storm in the night.—5th. 6 A.M., and 9 A.M, fog and drizzling. Cold and stormy till noon.—7th. 3 P.M., clear, few cumuli in W: 9 P.M., cloudy in W. and S.—8th. 6. A.M., and 9 A.M., heavy ground swell from E.—10th. 12 M., cumuli in W.: 3 P.M., squally in W., threatening rain: 6 P.M., cloudy, threatening rain.—11th. 9 A.M., dense fog: 12 M., cirri, sun shone a little.—12th 9 A.M., 12 M., and 3 P.M., dense fog: 6 P.M, few cirri: 9 P.M., some clouds.—13th. 6 A.M, cirri: 9 A.M., cloudy: 12 M., cloudy, thunder in west: 3 P.M., rain and fog from 2 P.M. to 3: 6 P.M., fog and rain.—15th. 12 M., few cirri.—Wind E N.E. at 4 P.M.—16th. 9 A.M., cloudy, thunder: 3 P.M., squalls and calm: 9 P.M., cloudy. Thunder shower and vivid lightning at 10 A.M.; heavy at 12h. 30m.; heavy wind and sea all day and night from W. and N W.—19th. 6 A.M., and 9 A.M., clear, few cirri: 6 P.M., few cirri. Heavy wind and sea all day.—25th. 6 P.M., and 9 P.M., cloudy. Wind strong, and in heavy squalls all day and night.—26th 6 A.M, a little rain: 12 M., cloudy, partly clear. Stormy; wind blowing a gale part of time.—27th. Wind shifted from west to N.W. at 4 P.M., and thermometer fell 10° in a moment, and 29° in a few hours; heavy gale on lake to N.W. and west.—29th. 6 A.M., and 9 A.M, cloudy: 12 M., rain since 10 A.M.: 3 P.M., 6 P.M., and 9 P M., storming. Cold stormy day.—30th. 6 A.M., and 3 P.M., cloudy.—31st. 12 M., clear in spots.—*September* 1st. 12 M., some clouds.—2d. 6 A.M., cloudy, clear at 5 A.M.: 12 M., raining, thunder in south: 3 P.M., severe storm and heavy rain: 6 P.M., severe storm, wind and rain: 9 P.M., rain storm. Severe and cold storm.—4th. 3 P.M., cloudy and rain. Heavy wind from west and south in night.—5th. 6 P.M., heavy storm clouds in west.

TABLE II.—*Register of Observations made at Copper Harbor, Lake Superior, from July 15th to 29th, Lat. 47° 28′ N.; Long. about 88° W. of Greenwich.*

Day.	Hour. h. m.	A.M. & P.M.	Bar.	Th. att.	Barometric waves of water.	Remarks.
15	6 00	A.M.	29·288	72	. . .	
"	9	"	·220	77	Water varied 1½ feet in a few minutes, and in a few more sunk a foot below the *usual* level.	
"	10	"	·200	80	Water higher than usual, although the wind is blowing off shore.	Wind blowing towards a heavy thunder-storm in W. and N.W; wind S.E. 5.
"	11 15	"	·480		Water suddenly fell one foot, Strong current along shore to east outside of the island.	Wind S.E. 4.
"	11 20	"	·264	78	Water running into the bay with great velocity.	Wind N.W. 9; constant roar of thunder and very vivid lightning; wind in an instant shifted from S.E. to N.W., uprooting trees, blowing down tents, &c.; lake a sheet of foam; heavy rain.
"	11 25	"	·260		. . .	Wind N.W. 9. Lake a sheet of foam; heavy rain.
"	11 40	"	·356		. . .	Wind N.W. 8. Lake a sheet of foam; heavy rain.
"	11 50	"	·316		. . .	Lull of wind; another gust coming on.
"	11 55	"	·328		. . .	Calm.
"	12 05	P.M.	·300		. . .	"
"	12 08	"	·260		Water a foot lower than usual, and flowing into bay from the lake with a strong current.	Calm; clearing in N.W., and sun soon came out.
"	12 15	"	·256		. . .	Calm.
"	12 20	"	·250	74	. . .	"
"	12 30	"	·251		Water high on lake shore, flowing rapidly into the harbor.	" clear in N. and N.W.; heavy thunder to E.N.E. and S.E.
"	12 40	"	·236	73	. . .	Calm.
"	1	"	·220		. . .	Wind S.S.E. 1; clear N. and N.W.
"	1 40	"	·206	70	. . .	Wind S.S.E. 2; another shower apparently coming from S.S.W. and W.
"	2	"	·200	69	. . .	Wind S. by W. 4.
"	2 15	"	·200	68	Water high in bay.	" " " 4.
"	2 20	"	·200	68	Water fallen 9 in. in 5 minutes in bay, and is 9 in. still lower on the outside of island. Running out with strong current.	" " " 4.
"	2 22	"	·204	68	Water 4 inches lower than at 2h. 20m.	Very strong breeze S. by W. 5; white caps all over the bay.
"	2 25	"	·200		Water stationary in bay and on lake shore.	Very strong breeze S. by W. 6; white caps all over the bay.
"	2 30	"	·200		Water rising rapidly in bay.	Very strong breeze S. by W. 6.
"	2 35	"	·192		Water risen 6 inches in bay.	" " " " " 6.
"	2 40	"	·190	68	Water fallen 8 in. in bay.	" " " " " 6.
"	2 50	"	·172		Water risen a full foot above its usual level.	Wind S. by W. 6.

TABLE II.—(*Continued.*)

Day.	Hour. h. m.	A.M. & P.M.	Bar.	Th. att.	Barometric waves of water.	Remarks.
15	2 55	P.M.	29·170		Water still up, but fallen a little.	Wind s. by w. 6.
"	3	"	·170		Water fallen a foot to its usual level.	" " " 6.
"	3 20	"	·190		Water fallen a foot *below* usual level.	" " " 6.
"	3 30	"	·182		Water risen a foot to the usual level.	" " " 6.
"	3 40	"	·180		Water fallen 1½ feet.	" " " 6.
"	3 50	"	·180		Water risen 1½ feet.	" s.s.w. 4.
"	4 10	"	·176		Water rising and falling a foot every few minutes.	" " 4.
"	4 20	"	·170	68	. . .	" s. by w. 4.
"	5 50	"	·150	70	. . .	Calm; heavy wind clouds to s. and s.w.
"	6	"	·150	70	. . .	
"	9	"	·300	70	. . .	Wind s.s.w. 1; thunder cloud in west.
"	10	"	·200		. . .	
16	1 40	A.M.	·200		. . .	Wind N.W. 6; thunder for hours in the west; heavy driving rain; heaviest rain from 2 A M. to 2h. 40m. A.M.
"	2 20	"			. . .	Wind N.W. 9.
"	6	"	·220	70	. . .	" S.W. 2.
"	8	"	·190	72	. . .	" S.E. 1.
"	9	"	·160	69	Water at medium height.	" " 5.
"	12	M.	·151	74	. . .	" S.W. 1.
"	12 30	P.M.			Water very high in bay.	
"	12 35	"			Water gone down one foot.	
"	3	"	·159	73	. . .	" s. by w. 1.
"	4 25	"	·150	70	. . .	Raining gently; thunder in w.
"	5 20		·128	70	. . .	" " " "
"	5 40	"	·128	"	. . .	" " " "
"	6	"	·130	72	. . .	Wind w. 1.
"	7 20	"	·150	"	. . .	Clear in west and N.W.; sun shining; rainbow in east.
"	8	"	·150	"	. . .	Wind s.w. by s. 3; thunder clouds in west and north.
"	8 35	"	·150	74	. . .	Calm.
"	9	"	·150	72	. . .	Wind s.s.w. 2.
"	10 10	"	·170	"	. . .	Calm.
17	9 40	A.M.	·420	69	. . .	Wind w. 4.
"	10 30	"	·450	67	. . .	" " 4; fog coming on.
"	1 40	P M.	·480	64	. . .	" " 1.
"	2	"	·480	"	. . .	" " 1; drizzling rain.
"	4 30	"	·490	"	. . .	" N.W. by w. 1; "
18	10 40	A.M.	·548	66	. . .	" w. 1.
"	12 30	P.M.	·540	64	. . .	" N.W. 1.
"	3 30	P.M.	·530	68	. . .	" " 1; temperature of lake water on the shore, 62°.
"	5	"	·520	64	. . .	Wind N. 1.
"	5 45	"	·510	"	. . .	" " 1.
19	10 40	A.M.	·440	69	. . .	" " 1; temperature of water on shore 65°.
"	2 20	P.M.	·412	"	. . .	Wind N. ½.
"	4	"	·360	"	. . .	" east, and in a few minutes shifted to S.E.; sky looked threatening.
"	5	"	·348	70	. . .	Wind s. 4; temperature of water on lake shore, 64°.
20	1 30	P.M.	·265		. . .	Wind S.E. 5.

TABLE II.—(*Continued.*)

Day.	H mr. h. m.	A.M. & P.M.	Bar.	Th. at.	Barometric waves of water.	Remarks.
20	9 40	P.M.	29·170		. . .	Wind s.w. 4; circle around the moon.
21	8 30	A.M	·100		. . .	Wind w.n.w. 5.
"	11	"	·160		. . .	" n.n.w. 5.
"	7 40	P.M.	·260		Sudden fall of water in bay of about 8 inches.	" w. 5.
22	11	A.M.	·556		. . .	
"	6 40	P.M.	·550		. . .	" n w. 1; squall clouds in north; thunder clouds in n., n.e. and s.w.
23	.	.	. .	.	. . .	Temperature of the water on shore, with wind at west and s.w. two days, 60°.
24	1 30	P.M.	·425	72	. . .	Calm; cloudy.
"	2 30	"	·360	"	. . .	Wind s. by w. 3; raining a little.
25	8 30	A.M.	·266	63	Water in the bay a foot above the usual level, and fell again in a few minutes.	Wind s.w. 1; lake rough with a heavy ground swell, from wind at a distance.
"	11	"			Ibid.	
29	4 30	A.M.	28·971	62	. . .	Wind s.w. 4; heavy black clouds in east; rained hard in the night.
"	10	P.M.	. .	.	. . .	Storm began with wind in the morning at 9 o'clock, but did not rain till 1 P.M.; fine misty rain; continues blowing hard and storming.
30	.	.	. .	.	. . .	Storm continued all day.

Throughout the preceding table where time is registered, fluctuations in the level of the water were observed, though the amount of rise and fall was not always registered. As a general thing, fluctuations in the barometer accompanied the fluctuations in the level of the water; but sometimes the water level varied rapidly in the harbor, while no such variations occurred in the barometer at the place of observation. These variations in the level of the water, may be caused by varied barometric pressure of the air on the water, either at the place of observation, or at some distant point. A local increased pressure of the atmosphere at the place of observation, would lower the water level where there is a wide expanse of water; or a diminished pressure under the same circumstances, would cause the water to rise above its usual level. If the barometer remain stationary at the place of observation, an increased pressure at a distant part of the lake would cause the water to rise; and a diminished pressure at such a point, would cause it to sink at the place of observation. During the last three summers, I have been on and near the coast of Lake Superior, much of the time coasting in a boat, and encamping on the shore. I have often observed at the mouths of streams, when encamped, that the outward flow of the water would be interrupted, and a strong current flow into the river or creek un-

til the water was raised from two or three to sixteen or eighteen inches above its common level, and after remaining thus for a few minutes or sometimes a longer period, again flow into the lake with a strong current, until the usual level of the water on the bar is attained. Sometimes the water of the lake would also recede below its usual level, so as to leave the bars naked that were generally covered with water. Toward the extremities of long lakes and bays, the wind causes very sensible fluctuations in the level of the water, which have long been observed at Whitehall and Buffalo, N. Y. The variations in level in Green Bay, observed by many persons, and carefully registered by Mr. Cass in 1828, and by Lieut. Ruggles in Sept. and Oct., 1836, are believed to be due to the influences of the wind *in part*, but *mostly* to variation of atmospheric pressure.

Copper Harbor is situated nearly in the centre of Lake Superior, near the extremity of a peninsula extending about seventy miles into the lake; and whatever may be the direction or force of the wind, the water retains its level so far as this cause is concerned in producing variations of level. The place of observation (on Porter's Island) is entirely sheltered from any influence of the waves, which break with great force in storms on the reefs and shore, on the outside of the island. It is in a little bay on the south side of the island, and opens into Copper Harbor. Copper Harbor is three miles in length parallel to the lake coast, and opens with a breadth of a mile. Any fluctuations that are not momentary, like those of the waves produced by wind, are perceived in a few minutes at the place where the observations were made, both by the variation of level, and by the rapid flow into or out of the harbor in the narrow opening that separates the west end of Porter's Island from the main land.

The quantity of water flowing through the rapids at the Sault St. Marie, at the outlet of Lake Superior, is subject to very considerable variation, and is dependent on two causes, viz., the direction and force of the wind, and, second, upon barometric waves. Capt. Peck, who resides at the Sault St. Marie, related to me instances in which the smooth flat rocks at the head of the rapids were bare for a considerable distance on or near the Canada shore, where ordinarily there was a strong current. He had walked far out on these rocks, but observation had taught him not to tarry long, as the water would return sometimes in half an hour; these depressions of the water usually preceded a storm.

During my visit to the Sault on the 7th of Sept. last, the water was remarkably low on the rapids all day, being one and a half feet lower than usual. A daring New England man wishing to see if the falls could be ascended, made the attempt in a sharp skiff sail boat, with a strong fair wind, almost a gale, and succeeded—a thing never before attempted, or even deemed possible.

A heavy rain storm from the N. and N.W. succeeded on the following day.

Many observing men on the lakes have noticed that the extraordinary variations in the level of the water precede a storm. I regret that I did not accurately note down more of them. The preceding notes may call the attention of those favorably situated for these investigations, carefully to observe the attending circumstances, and especially the barometric fluctuations, wind, weather, and temperature. A rise of the barometer in the annulus of a storm precedes the depression, and would account for the fluctuations of level, whether the variations in atmospheric pressure occur at the place of observation or at some distant point, on a broad expanse of water.

Periodical Rise and Fall of Lake Superior.—The gradual rise and fall of the level of the water in the great lakes, through a series of years, has long been noticed. Its cause is doubtless due to a greater quantity of rain and snow, or of a lower mean of temperature and diminished evaporation during the period of rise, and the reverse during the time of fall of the water-level of the lakes. During the year 1838 or 1839, the waters were higher than they had been before for at least two centuries. This is demonstrated by the large tracts of land that were inundated, which are covered with forest trees, many of them the growth of ages. These trees were destroyed by this overflow around Lakes Erie and Huron and on the St. Mary's river, between Point Detour and the Sault St. Marie.

We have no accounts of Lake Superior at that time, and I have seen no similar tracts of destroyed timber on the shores of that lake, although I have coasted along most of the shore. There are facts however that indicate a marked variation within a few years. In 1845 a rock in the middle of the entrance of Eagle Harbor showed itself only in the trough of the waves; and the narrow inlet betwen the west end of Porter's Island and the main land at Copper Harbor, was of such depth that loaded Macinaw boats could enter Copper Harbor without touching the rocks. In the summer of 1846 the rock at the mouth of Eagle Harbor was a foot and a half above water; boats could not get into Copper Harbor through the inlet above mentioned, and skiffs and canoes rarely attempted to enter by that passage. In June, 1847, the rock above mentioned was still more out of water, and the western inlet to Copper Harbor could be crossed, by stepping on the projecting points of the reef, without wetting the feet; and during some depressions of the water by barometric waves, it was laid almost entirely dry. From the 18th of June to the 6th of September the general level of the water rose fully twelve inches. Several large rocks in the water opposite the government house, with their points projecting at different heights above

the water, were daily observed (except from the 3d to the 8th of August), when the water was calm, and a steady progressive rise noticed by means of them, the lowest being first covered and others in succession. It has been observed on this lake, that the water is lowest in spring and highest in autumn. This is readily explained by the fact that in winter most of the ordinary supplies of water from the drainage of the surrounding country, are cut off by being converted into ice and snow, while evaporation from the surface of the lake by the dry northern winds continues to carry away a very sensible quantity of water. During the spring and early part of summer* the snow and ice melt, and the accumulated stores of winter, flow into the lake in greater quantity than to compensate for the evaporation and the drainage at the outlet. The summer of 1846 was remarkably dry and warm; that of 1847 more than usually cold and wet. A small canal was cut some years since, from the head of the rapids at the Sault St. Marie, to supply the government saw mill near the foot of the rapids with water, and boats used to navigate this canal to the saw mill. In 1845 a little water entered this canal, perhaps eight inches to twelve inches in depth. In 1846 and 1847 the water did not ordinarily come within a foot or more of the level of its bottom.

Ancient Levels of the Lake.—During a century past, the waters of Lake Superior cannot have been more than four feet above the level of the summer of 1847, for any considerable length of time. This is evident from the growth of trees of two feet in diameter on Porter's Island, within one hundred yards of the Government House that would have died had the ground around been inundated for any length of time.

The evidences of higher levels of this lake in times more remote, but during the modern epoch, are numerous and striking. They consist in the beaches of shingle, and sand, and gravel, in successive elevations. The shingle and pebble beaches may be seen, well characterized, between Copper Harbor and Lake Fanny Hooe at Fort Wilkins, from the lake beach to a height of about forty feet. The sand beaches and dunes, may be seen at the mouths of Huron and Pine Rivers, and near Presque Isle, between the Presque Isle River and Point Abbaye; also east and west of Eagle River, from Eagle Harbor to the Portage, for about twenty-five miles; also most of the distance between Elm River, Sleeping River, Misery, Flint-steel, Fire-steel, Ontonagon and Iron Rivers, where the rocky coast is not too high to break the force of the waves when the lake was above its present level.

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* On the 20th of June, 1847, snow still remained in the swamp on Porter's Island, two feet in depth, over a small area where the evergreen trees were so thick that the sun's rays could scarcely penetrate.

The most remarkable dunes or hills of blown sand, observed, are those w.s.w. of Eagle Harbor, between there and Sand Bay, which are fifty feet or sixty feet high on the coast, and much higher in the interior, near the base of the hills; those near Eagle River to the west four to five miles; and those at the mouth of Pic River on the Canada shore. Dunes of twenty feet to forty feet high are common in almost every part of the lake coast where sand beaches are formed, and where the strong dry winds can sweep over a considerable length of beach. The highest and most remarkable dunes are so situated as to demonstrate that the westerly and northwesterly winds are the prevailing ones, that blow with force enough to drift much sand. Mr. Schoolcraft has described remarkable dunes on the lake coast, three hundred feet high,* between Grand Island and White Fish Point. All who have coasted that shore, have observed them.

An estuary deposit at the mouth of Pic River, may also be adduced as an evidence of a former higher level of the lake. This is about twenty feet to forty feet above the lake, nearly level, and where the river was cutting it away, great numbers of fresh-water bivalve shells were found, such as are now living in great numbers in the adjacent waters, and occur on the beach. This deposit is not blown sand, as it is nearly level, while that near the beach is piled in hills sixty feet to seventy feet high, and continually encroaching upon the level estuary deposit, burying the forest on the landward side in its progress.

Lake Superior, so far as is known, does not show any indication of having had any other outlet than that through which its surplus water now flows, and so far as the facts observed justify any conclusion, we may infer, that the lowering of level indicated by the preceding facts, may be ascribed to the gradual wearing down of its outlet at the Sault St. Marie. The rocks at this place are gray and red variegated sandstones highly indurated, which wear away with extreme slowness. They are nearly horizontal in position, and dip slightly to the west and northwest. The outlet in former times, when the lake was twenty feet or thirty feet higher, must have been two miles in width, but shallow; the flat lands at the Portage of the Sault St. Marie, consist of gravel and boulder of almost every variety of rock found on the shores of Lake Superior, intermixed with loam, and these materials rest on the flat and often smoothed surface of the subjacent sandstone.

The facts considered as demonstrating a water level some hundred feet above the present level will be adduced in another article on the geology of that region.

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* Am. Journal of Science, vol. xliv, p. 369.

Art. II.—*Contributions to the Geology of Texas;* by Dr. Ferdinand Rœmer.

At the time when I wrote the short sketch of the geology of Texas, contained in a previous number of this Journal,* I had seen only a comparatively small portion of the country. I have since extended my observations over a much larger surface and, profiting by some peculiarly favorable circumstances, I have become acquainted with sections of the country generally considered inaccessible on account of the dangerous character of the Indian tribes by which they are inhabited.

I have collected a sufficient number of facts for a geological map of the whole state, which will be true at least in all its general features. My collections of fossils will serve to test the correctness of the observation and the inferences drawn from them. They contain a considerable number of new forms, chiefly from the cretaceous formation, which require to be described.

At present I wish only to present a short account of the general results which I have derived from my geological survey of the country.

An ideal line drawn from Presidio de Rio Grande on the Rio Grande in a N.E. direction, and crossing the San Antonio River at the town of the same name, the Guadaloupe at New Braunfels, (the German settlement,) the Colorado at Austin, the Brazos at the falls of this river, the Trinity below its forks, and reaching from there to the Red River in the same N.E. direction, divides the tertiary strata and the diluvial and alluvial deposits (of the level and "rolling" part of the country) from the cretaceous and older formations (of the hilly and mountainous sections).

The few remarks to be made about the former region, are first that the tract of level country which extends like a broad belt along almost the whole coast of Texas, is diluvial and partly alluvial in character. Its small elevation of a few feet only above the level of the sea, and its perfectly level surface, indicate, at once, the recent origin of the soil. The fossil remains, found in many places in the deposits of clay and sand, prove their modern age still more conclusively. At the head of Galveston bay and even near the town of Houston, I found at a height of twelve to twenty feet above the general level of the bay, large deposits of shells of Gnathodon, a bivalve mollusc, which lives abundantly in the brackish waters along the coast of the Mexican Gulf, and in the bay of Galveston particularly. Some few oyster shells of the common kind occur in these deposits of half fossilized Gna-

* Volume ii, ii Ser., p. 358.

thodon shells, but there are no shells different from those now living in the bay. Every thing tends to the supposition that the conditions of climate, etc., at the period when these deposits along the coast of Texas were formed, did not differ materially from the present, except that a change in the relative level of land and sea has since taken place.

To the diluvial period must be likewise referred the deposits of clay and sand which form the banks of the Brazos and probably all the other large rivers of the country. Mr. Hough, a gentleman residing at San Felipe, has discovered in the muddy banks of the Brazos near his place of residence, many fossil bones of extinct species of mammalia, and has made a valuable collection of them, which I had an opportunity to examine when it was exhibited about two years ago at Galveston. It contains bones of mastodon, megalonyx (claw bones), tapir, and of a gigantic and undescribed species of ox.*

To the diluvial age of the globe must be further referred the *deposits of gravel and sand*, which form a broad belt of barren or poor land covered with pine and post-oak timber, in the "rolling" or undulating portion of Texas, and extending from west to east across a considerable part of the country. Following up the Colorado from Columbus to Bastrop, or the Guadaloupe from Gonzales to Seguin, we pass directly across this belt. The gravel is mostly composed of pebbles of silex evidently derived from decomposed cretaceous strata. Within the limits of this gravel formation, fossil wood of dicotyledonous trees in smaller or larger fragments is found almost every where. In some localities it is particularly abundant, and whole trunks are occasionally met with. I have sent to Europe the lower part of a trunk, about three and a half feet in diameter, weighing about six hundred pounds, and showing distinctly the beginning of the ramification of the roots and most beautifully the fibrous internal structure of the wood. This specimen was discovered together with many smaller ones, in the banks of a small creek near the town of Boonville on the Brazos. When I wrote my former paper, I was not sure about the formation in which this fossil wood was originally deposited. I am now perfectly convinced that it is derived from cretaceous strata, having afterwards found pieces of it among cretaceous fossils at localities where for hundreds of miles around, there are no other but cretaceous strata, and no traces of diluvium or drift are met with.

Strata, belonging decidedly to the *tertiary* period, I did not see at all during the first part of my stay in the country, and I was inclined almost to doubt their existence in Texas altogether, although this would have been against the general analogy of the

* This Journal, volume i, ii Ser., p. 244.

other southern states. While on a tour to the upper Brazos, I discovered in the neighborhood of the town of Caldwell, strata of a ferruginous sandstone with numerous and well preserved tertiary shells. Crossing afterwards the Brazos not far from this town, I had a still better opportunity to see this formation along the steep banks of the river. It consists of alternating strata of brown ferruginous sandstone and of dark colored plastic clay, both teeming with fossils. Unfortunately, the circumstances did not allow me to make a complete collection of them; the few, however, which I gathered are sufficient to prove that those strata belong to one of the older divisions of the tertiary period. I have good reason to suppose that these same tertiary deposits have a wide range in the eastern part of Texas, though I am unable to give their exact limits. Tertiary fossils from Nacogdoches seem to indicate that the deposits of the Brazos extend as far as there.

Cretaceous formation.—We come next to the *cretaceous* strata, which of all the stratified formations take the most important part in the geological constitution of Texas and chiefly her upper hilly part. The immense tract of land which extends from the above mentioned line, connecting the Rio Grande with Red River, to the head waters of the Colorado and the other large rivers of Texas, is occupied entirely by cretaceous deposits, except a belt of silurian and carboniferous strata and a mass of granitic rocks, both covering comparatively a small area.

When we examine first the mineralogical constitution of these cretaceous rocks, a striking difference from other deposits of the cretaceous period on the North American continent at once becomes apparent; for whereas these latter, on the whole Atlantic coast, are almost entirely composed of loose and incoherent materials, the cretaceous strata of Texas constitute mostly compact and hard rocks, some of them equalling in compactness the hardest strata of more ancient secondary formations. A calcareous character is very commonly observed; in fact, I have not seen any sandstones or strata of clay in the whole series. Generally speaking, there is an alternation of compact siliceous limestones and less compact beds of either pure, or marly, limestone. The former contain the silex as well diffused through their whole mass, as in separate concretions or nodules. The siliceous character of these rocks, excluding the decomposing action of the atmosphere, almost entirely produces the general dry and barren aspect of the country which they occupy. Every where in the mountainous region, north from Austin or San Antonio de Bexar, on both sides of the Piedernales and San Saba Rivers, it is only in the valleys that a fertile stratum of soil is found; on the heights of the table land the bare rock appears almost every where at the surface, hardly supporting the scanty growth of grass and some scattered specimens of stunted live-oak and post-oak trees.

In regard to the organic character of these strata, the opinion expressed in my first paper has, on the whole, been confirmed by later researches, and is at present supported by a much greater number of facts. Most of the fossils belong to known types of the cretaceous formation. The number of species, however, exactly identical with described species is very limited. By comparing the fossils with those of the different divisions of the cretaceous formation as they are established in Europe, it appears that the rocks of Texas do not agree in any particular with received divisions. It is evident only that they belong to the upper part of the cretaceous formation, for there is a complete absence of all the characteristic forms of the gault and lower greensand, and on the other hand, there is an undoubted analogy with the organic character of the chalk and chalk marl.

Notwithstanding the considerable thickness of the whole system of strata, (which cannot be less than about eight hundred feet,) it seems impossible to divide it into different groups. Neither the mineralogical constitution of the rocks, nor the distribution of the organic remains allows of any such division. By a comparison of these cretaceous deposits with those of New Jersey, and other localities on the Atlantic coast, the difference in the zoological character appears hardly less striking than the difference in the mineralogical constitution which was alluded to before. Except the *Pecten quadricostatus* and the *Exogyra costata*, (the latter being rare in Texas,) I do not know of any other identical species, and the number of closely allied species is not very small. A little more analogy seems to exist with the cretaceous deposits of Alabama and Western Tennessee. At least a species of Ammonite, common at Prairie Bluff in Alabama, occurs also in Western Texas, and a species of Hippurite is closely allied to a species which I found at Austin, Texas, if not identical with it.

The analogy of the Texian strata with the cretaceous deposits on the Upper Missouri, is hardly greater than with those on the Atlantic coast. Not one of those beautiful species of *Scaphite*, *Baculite* and *Ammonite*, discovered by Nicollet, and described by Morton,* has been met with in Texas.

The entire absence of the *Belemnites mucronatus*, and every other *Belemnite*, is one of the principal negative characters of the Texian strata.

It is more difficult to define in a few words, the positive character of the Fauna.

All the species except a very few, (which form perhaps two new genera,) belong to genera which are either peculiar to, (as for instance, *Baculites*, *Turrilites*, etc.,) or are represented in the cretaceous formation.

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*Journal of the Acad. of Nat. Sc. Philad., vol. viii., p. 2.

Among the latter, the genus *Exogyra*, acts a very important part in the constitution of the fauna, some species of the genus having a very wide geographical range, and occurring almost everywhere in a great number of individuals. One species which resembles a Chama in external shape, composes at some localities, whole beds of itself, and is met with through the whole extent of the hilly parts of Texas.

Another still more important fact must be considered in the general distribution throughout the whole formation of the genera *Hippurites* and *Caprina*. The former being entirely wanting in the cretaceous deposits of New Jersey, makes its first appearance towards the south, in the cretaceous strata of Alabama, where it is represented by one single species, of which only a few specimens have been hitherto discovered.* In Texas, at least three species of the same genus have been recognized, and those are of wide and frequent occurrence. The genus Caprina which has never been met with, either in New Jersey, or in Alabama, is one of the most characteristic and abundant types in the siliceous limestone of Texas. One species in some places constitutes of itself whole strata. It is well known that these two genera act an equally important part in the cretaceous strata in the Alps and around the Mediterranean, whereas they are hardly represented at all in the cretaceous formation of England and Germany. An interesting analogy is hereby established between the Texian deposits of the cretaceous period, and those of the south of Europe, the more striking, if we consider at the same time, the similarity of mineralogical constitution. Between the continents of America and Europe, there must therefore have existed at the time of the cretaceous period, such a relation that in both, the same modifications in the zoological character distinguished the marine Fauna of the north from that of the south. And thence, we proceed farther to the interesting conclusion, that the same southern inflection of the isothermal lines which is at present so remarkable in their course from the west side of the continent of Europe towards the east side of the continent of America, already existed at a period of the globe, as remote as that of the cretaceous formation.

Strata older than Cretaceous.—At the time when I wrote my first paper on the geology of Texas, I had no knowledge of the existence in the country, of any strata older than the cretaceous deposits, except that there was a single rock of granite about fifteen miles northeast of Fredericksburg. But in the early part of this year, a short time before my leaving the country, I had a

* I saw a specimen of this species at Philadelphia, in the Museum of the Acad. of Natural Sciences, which has been brought from Green county, Alabama, by Mr. Conrad.

very favorable opportunity to visit that section of country which lies between the Piedernales, Llano, and San Saba, (all three of them tributaries of the Colorado,) and which, on account of the dangerous character of the Indians by whom it is inhabited, has remained until now, almost entirely unknown. In this region, I found besides the cretaceous formation, not only an extensive tract of granite, and other crystalline rocks, but also stratified deposits, which from the fossils they contain, are clearly Silurian strata, and carboniferous limestone. In order to make the geographical distribution of these rocks distinctly understood, it will be necessary first, to point out the route which I took in the exploration of this region. Starting from Fredericksburg, a German settlement which is situated about ninety miles north of the town of San Antonio de Bexar, and about four miles from the Piedernales, we took a northwestern course, and followed it not only as far as the Llano river, but also beyond it, until we reached the San Saba. We then ascended the valley of this river about fifty miles, until we reached the San Saba, that is to say, beyond the ruins of the old Spanish fort, and within about eight miles of the sources of the river. From there, we went down the valley again, passed the point where we first struck it, and continued descending the valley, until we arrived at a camp of the Camanche Indians, about twenty-five miles from the mouth of the river. There we left the valley of the San Saba, and went back to Fredericksburg, in an almost exactly southern course. On this tour the following rocks were observed.

From the Piedernales to the Llano, the same cretaceous strata extend, which, consisting of a compact white, or yellowish limestone, with occasional nodules of flint, occupy likewise the whole tract of land from the Piedernales down to San Antonio and Austin. On the banks of the Llano, a calcareous sandstone distinctly stratified, but evidently much altered, begins to show itself; its extension, however, is only a limited one, for about five miles beyond the river it is superseded by granite. This latter rock, occupies almost the whole tract of country between the Llano and San Saba, and it is only on the dividing ridge of the last mentioned river, that limestone beds reappear again.

The granite is on the whole, coarse grained, and appears red from the color of the feldspar. It constitutes either large rocks with bold outlines, or flattened masses, which project only very little above the surface of the ground, and become visible mostly in the beds of several small streams, by which the country is intersected.

About ten miles from the place where we first entered the San Saba valley, on the right bank of the river, horizontal beds of limestone, of a decidedly Palæozoic character, were first met with. This limestone, of a grayish impure color and of a granular struc-

ture, bears strong evidence of alteration by the action of heated plutonic rocks. This igneous action has not however obliterated all the organic remains of the limestone. Fossils, on the contrary, although not of many species, are abundant. Among them Trilobites are especially numerous. Those which I collected belong to the genera *Asaphus* and *Bronteus*. In specific characters they differ from many found in the valley of the Mississippi, or in other palæozoic strata of America. Besides these Trilobites, some indistinct species of Orthis were found at the same locality. Some miles further up this river, at a place where the limestone does not exhibit any marks of plutonic action, some other genera of fossils are met with, as for instance *Euomphalus*, *Spirifer*, etc. Of the latter genus one species was found which is closely allied to the *Spirifer lynx*, Eichw., a fossil shell so widely spread in the beds of Trenton limestone of the state of New York, and the corresponding strata of the western states. In ascending still higher the valley of the San Saba, we lost sight of all Palæozoic strata, cretaceous strata of the same character as those which we had seen before, taking their place at the surface, and occupying especially all the neighborhood of the old Spanish fort. We met Silurian strata again nearer to the mouth of the San Saba river. Here they consisted of a white siliceous limestone, evidently much altered, although not to such a degree as to destroy all marks of organic remains. A species of Euomphalus with a great number of whorls, analogous to a species from the Silurian strata of Russia, could be distinctly recognized. Still further down the river, and about thirty miles from its mouth, we found in the narrow valley of a tributary of the San Saba river, inclined strata of a dark colored compact limestone, with layers and nodules of black silex. These beds of limestone abound with fossils which evidently belong to the carboniferous period, and some of them are even exactly identical with species of the carboniferous limestone of the Mississippi valley. Most of the species which were observed in the very short examination of the locality, belong to the genera *Productus*, *Spirifer*, and *Terebratula*.

On our return from the San Saba to Fredericksburg, we crossed again the same belt of granitic rocks which we had seen previously after passing the Llano, and did not observe any cretaceous strata before reaching the dividing ridge of the Piedernales and Llano.

The main results of this journey, as well as of former investigations, may be more clearly exhibited in the following statements.

The immense tract of hilly or mountainous country extending from the Rio Grande to Red River, is mostly formed by strata of the cretaceous formation differing in their fossil fauna from the

cretaceous deposits in New Jersey and in other localities on the Atlantic coast, but exhibiting a striking analogy with some of the cretaceous deposits in the south of Europe around the Mediterranean, in the same degree as those of the Atlantic coast are similar to the cretaceous deposits of England and northern Germany. Surrounded by these cretaceous deposits, there exists between the Piedernales and San Saba rivers, a belt of granitic rocks and of palæozoic strata. The latter are characterized by their fossils as Silurian strata and carboniferous limestone, both are different in their organic characters from the corresponding formations in the Mississippi valley, as might be expected considering the great distance and difference of latitude.

As a fact bearing on the geography of the western part of Texas, I will mention before concluding this paper, that the range of mountains which, under the name of the San Saba mountains, is laid down on some maps, does not exist. On either side of the San Saba river no elevation of any importance is seen above the general level of the table land.

The detail of my geological researches in Texas will be given in a more elaborate work. The publication of which will take place with the least possible delay.

Berlin, August, 1847.

Art. III.—*On the Orbits of the Asteroids;* by B. A. Gould, Jr., A.A.S.

The recent discoveries of Hencke and of Hind, by which the number of small planets known to us between the orbits of Mars and Jupiter has been doubled, have directed the attention and interest of astronomers in a still higher degree to the group of these remarkable bodies.

By the common consent of astronomers, they have received the name of "asteroids," a name proposed by the elder Herschel, in consequence of a theory of his own. The word asteroid, in its present signification, may be defined as "a small planetary body, which revolves around the sun between the orbits of Mars and of Jupiter."

Immediately upon the discovery of Pallas, the calculations of Gauss showed that the orbits of Ceres and Pallas approach very near to one another in the descending node of Pallas upon the Ceres-orbit.

Upon this fact Olbers grounded his well known and not unnatural hypothesis, that these two extremely small bodies, whose orbits approach one another so nearly in the node, were merely the fragments of a larger planet, which by some force unknown to us, had exploded or been shattered by some external shock.

For if this supposition be true, the planet would almost exactly have filled the gap between Mars and Jupiter, where, according to an empirical formula, much in vogue at that time, an unknown planet had been long suspected. Indeed a society of German astronomers had been already formed, to search for this suspected member of our solar system.

As a corroboration of this hypothesis, he referred to the circumstance that both Pallas and Ceres seemed to vary considerably in magnitude, which he explained by the conjecture that these bodies were not round, but of very irregular figure.

"This idea," he wrote to Zach,* "has at least one great advantage over some other hypotheses, that it can be soon tested. For if it is true, we shall be able to find still more fragments of the shattered planet, and the easier still, because all those fragments, which describe an elliptical orbit around the sun, must pass the descending node of Pallas upon the orbit of Ceres."

The discovery of Juno soon after, and not far from the apparent place of this node, seemed to afford a strong confirmation of Olbers's hypothesis, and Zach immediately began† to consider it a tested and confirmed theory.

A simple calculation gives however the following results:

	True anomaly of Ceres.
In ☋ of Pallas on the Ceres-orbit, - -	220° 9′ 56″·6
" " " Juno " " " " - -	242 2 18 ·3
	True anomaly of Pallas.
In ☊ of Ceres on the Pallas-orbit, - -	249° 32′ 36″·0
" " " Juno " " " " - -	232 33 1 ·9

In October, 1804, Olbers wrote‡ Zach again that the distance between the two nodes on the Ceres-orbit (the calculations of Gauss gave 24° at that time) was in no wise discordant with his hypothesis; that as a necessary consequence of the very different inclinations to the plane of Jupiter's orbit, the motion of their lines of nodes produced by Jupiter's attraction must be very different from the motion of their apsidal lines, which would result from the same attraction; that still farther, inasmuch as these orbits have nearly equal major-axes, but very unequal excentricities, they must have cut one another at some former time in their node upon the Ceres-orbit. Indeed if we assume according to the determinations of Oriani, the annual motion of the aphelion for Pallas = 106″·1, and for Ceres = 120″·9, and consider the nodes as sidereally at rest, and the inclinations constant, it results that a section of the Ceres and Pallas orbits in the above mentioned node, must have taken place 7463 years before, and in 282 years again occur. In the descending node the same would happen in 925 years.

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* Monatliche Correspondenz, vi, 88.
† M. C., x, 377, 8.
‡ M. C., x, 468.

Later, after Gauss had computed the secular variations of Ceres and Pallas, Encke, at his suggestion, made farther investigations for the purpose of determining whether the distance of the two orbits at the node, were on the increase or decrease. The result of his computations was, that the orbits are approaching one another.

Encke found* the following radius-vectors.

Year.	In the ☊ of Ceres on the Pallas-orbit.			In the ☋ of Ceres on the Pallas-orbit.		
	Ceres.	Pallas.	Diff.	Ceres.	Pallas.	Diff.
808	2·82284	2·70322	−0·11972	2·67612	2·37780	−0·29832
1808	2·92427	2·84945	−0·07482	2·59569	2·40346	−0·19223
3475	2·95374	2·95743	+0·00369	2·57987	2·49163	+0·08824

"According to this," to use the words† of Gauss, "a section in the node would actually take place about the year 3397, which may be considered, at any rate, as an approximation to the truth. To be sure a section must also at some former period have occurred; but from the progression of the numbers in the third and sixth columns, we can at least conclude that this can only have been many thousands of years before. If we therefore adopt the hypothesis of Dr. Olbers concerning the origin of the new planets, the occurrence must have taken place at an epoch, for us at present immeasurably long before the times to which history reaches back."

It is also evident from the foregoing table, that the distance between the two orbits in the descending node upon the Pallas-orbit, is at present on the decrease.

At any rate we are justified in concluding, without any farther computation of the secular variations, that at the last time that a section of the Pallas and Ceres orbits took place, neither of the nodes of Juno coincided with the node of Pallas. Although the subsequent discovery of five more asteroids has most certainly confirmed the conjecture of Olbers, that still more similar bodies would be found, it has nevertheless almost immeasurably multiplied the difficulties in our way;—if indeed it has not rendered it absolutely impossible to assign a period, by computation of the secular variations of the apsidal and nodal lines of these eight orbits, when at the same time all the nodal lines upon one of the orbits coincided, and all the radius vectors were equal.

In this place belongs, perhaps, the remark, that as far as we are yet able to determine the orbit of Flora, the aphelion of this planet falls within the perihelion distance of Ceres.

On the other hand, it must be mentioned that all the nodes upon the Ceres-orbit fall within a single quadrant.

The following table gives the distances of the several nodes upon the orbit of Ceres from one another. These distances are

* Monatliche Correspondenz, xxvi, 299. † M. C., xxvi, 299.

reckoned in heliocentric arcs upon the orbit, and counted from the Hebe-node, inasmuch as the latter lies nearest to the perihelion of Ceres, corresponding to a true anomaly of only 35° 20′.

	Distances from the node of Hebe on the Ceres-orbit.
Pallas,	4° 49′
Juno,	26 42
Vesta,	43 31
Astræa,	47 55
Flora,	50 18
Iris,	77 46

These interesting considerations seemed to me to make it worth while to make still more accurate and extensive investigations concerning the relative position of the asteroidal orbits. I have, therefore, for every pair of the eight known to us, i. e., for twenty-eight combinations, calculated the radius vectors in each node.

The elements of which I have made use are, for the four older asteroids, the osculating elements for the epoch nearest to the 1st January, 1848, which Dr. Bremiker in Berlin has computed. I am indebted for them to the kindness of Professor Gauss.

For the four newly discovered, I have selected those elements which, of all known to me, satisfy all observations best. These are for Astræa and for Hebe, the orbits* of Hrn. D'Arrest in Berlin; for Iris, the excellent orbit of Prof. Goldschmidt in Göttingen; and for Flora, an orbit lately published by myself.

The longitudes are referred to the mean Equinox of Jan. 1, 1848. The notation I have used, is that of the Theor. Motus.

Elements of the Orbits of the Asteroids.

	Epoche.	M	Ω − π	Ω	i	φ	μ
		° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	″
Pallas,	1848, March 4·0	24 57 23·4	51 26 35·1	172 42 12·3	34 37 31·1	13 54 48·9	768·8858
Hebe,	1847, July 10·0	274 54 2·6	123 36 42·1	138 40 44·8	14 44 25·3	11 31 11·4	942·3754
Juno,	1847, July 9·5	258 6 2·1	116 35 4·0	170 53 52·0	13 2 39·3	14 42 19·6	812·7012
Ceres,	1848, March 12·0	21 4 0·5	293 28 14·7	80 47 17·9	10 37 13·1	4 24 56·8	770·9866
Vesta,	1847, April 4·0	310 46 14·7	212 16 15·4	103 22 1·3	7 8 30·3	5 7 21·5	977·9481
Flora,	1848, Jan. 1·0	35 53 32·0	77 26 49·1	110 18 50·8	5 52 55·9	9 1 36·9	1086·1100
Iris,	1847, Sept. 1·0	298 16 37·2	218 18 35·6	259 45 19·6	5 28 10·9	13 20 50·1	963·4498
Astræa,	1847, March 16·0	63 30 49·3	6 0 31·4	141 29 29·2	5 19 17·1	10 49 55·6	857·8493

I subjoin the following table of subsidiary quantities, because, as far as my knowledge extends, they are no where else to be found together.

	Per. Dist.	Aph. Dist.	Period of rev. in sidereal days.
Pallas,	2·105304	3·438312	1685·55
Hebe,	1·936886	2·903557	1375·25
Juno,	1·993166	3·349363	1594·68
Ceres,	2·553746	2·979793	1680·96
Vesta,	2·150345	2·571997	1325·22
Flora,	1·856244	2·547126	1193·25
Iris,	1·834262	2·935335	1345·16
Astræa,	2·092456	3·060943	1510·75

* Ast. Nachr., xxv, p. 321; xxvi, p. 147.

From these elements I have employed the following table, where for the sake of simplicity and in order to have a definite rule, each orbit is referred to those other orbits whose inclination is inferior.

Upon the orbit of Astræa.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Astræa.	Rad. vect.	Rad. vect. Astræa.
Pallas-orbit,	2·308615	2·180479	3·005974	2·890263
Hebe . .	2·599472	2·092602	2·100824	3·060630
Juno . .	3·033050	2·807325	2·125046	2·230187
Ceres . .	2·775450	2·442815	2·725737	2·530106
Vesta .	2·562481	2·407127	2·157039	2·569565
Flora . .	1·862868	2·480134	2·534758	2·491281
Iris . .	2·083886	2·993750	2·463162	2·125061

Upon the orbit of Iris.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Iris.	Rad. vect.	Rad. vect. Iris.
Pallas-orbit,	2·214686	2·585784	3·181677	2·003507
Hebe . .	2·480293	2·193029	2·185698	2·326314
Juno . .	2·537652	2·420336	2·461760	2·115556
Ceres . .	2·669673	1·914261	2·863094	2·751336
Vesta . .	2·386301	2·427211	2·299979	2·110331
Flora . .	2·003169	1·989275	2·314213	2·609881

Upon the orbit of Flora.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Flora.	Rad. vect.	Rad. vect. Flora.
Pallas-orbit, .	2·340702	2·477143	2·953261	1·895266
Hebe .	2·743165	2·341091	2·015498	1·982454
Juno . .	3·140343	2·529811	2·075370	1·865549
Ceres .	2·766548	1·872111	2·734377	2·517845
Vesta . .	2·564879	1·958076	2·155343	2·377464

Upon the orbit of Vesta.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Vesta.	Rad. vect.	Rad. vect. Vesta.
Pallas-orbit,	2·361500	2·266614	2·920807	2·423312
Hebe . .	2·801046	2·335006	1·985355	2·349731
Juno . .	3·198536	2·210443	2·050712	2·490982
Ceres . .	2·791893	2·549792	2·710061	2·166114

Upon the orbit of Ceres.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Ceres.	Rad. vect.	Rad. vect. Ceres.
Pallas-orbit,	2·409084	2·597537	2·851153	2·922309
Hebe . .	2·889707	2·587842	1·943098	2·934678
Juno . .	3·255644	2·654538	2·027906	2·853377

Upon the orbit of Juno.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Juno.	Rad. vect.	Rad. vect. Juno.
Pallas-orbit,	2·278408	2·854559	3·058776	2·222411
Hebe .	2·120485	2·025683	2·569983	3·261389

Upon the orbit of Hebe.

	Ascending Node.		Descending Node.	
	Rad. vect.	Rad. vect. Hebe.	Rad. vect.	Rad. vect. Hebe.
Pallas-orbit,	2·432568	2·901680	2·818945	1·937722

Of these twenty-eight combinations there are eighteen cases in which the orbits lock into one another, like the links of a chain, and ten where the one orbit is entirely inclosed within the other.

Linked into one another are the following orbits:

Hebe and Astræa.	Hebe and Iris.	Ceres and Juno.
Juno " "	Vesta " "	Pallas " Hebe.
Vesta " "	Flora " "	Vesta " "
Flora " "	Pallas " Juno.	Ceres " "
Iris " "	Vesta " "	Pallas " Flora.
Pallas " Iris.	Hebe " "	Vesta " "

Entirely included are the following orbits:

Flora in that of Hebe.

Iris and Flora in that of Juno.

Astræa and Vesta in that of Pallas.

Iris, Flora and Pallas, and consequently, also Astræa and Vesta in that of Ceres.

I add a second table, similar to the foregoing, which shows the so-called *longitude in the orbit* for each of the nodes. The first two columns give the longitude of the ascending node of the first named orbit upon the second. The third contains the mutual inclinations of the two.

	Longitude in the first orbit.	Longitude in the second orbit.	Inclination.
Pallas and Astræa,	178° 11′ 18″·4	177° 20′ 19″·1	30° 11′ 5″·2
Hebe " "	137 9 18 ·6	137 11 19 ·5	9 25 42 ·0
Juno " "	188 13 4 ·1	187 55 12 ·9	8 47 54 ·0
Ceres " "	50 34 38 ·6	50 50 31 ·6	9 15 53 ·6
Vesta " "	55 16 47 ·4	55 29 4 ·3	4 24 46 ·0
Flora " "	46 0 56 ·6	46 9 58 ·6	3 3 12 ·9
Iris " "	290 15 51 ·6	290 2 24 ·2	9 15 33 ·4
Pallas and Iris,	163 4 58 ·1	164 47 7 ·2	34 43 19 ·6
Hebe " "	123 29 51 ·0	124 6 21 ·0	18 9 51 ·5
Juno " "	147 44 30 ·0	148 22 2 ·2	14 1 30 ·7
Ceres " "	80 25 59 ·0	80 26 32 ·2	16 5 21 ·9
Vesta " "	149 11 25 ·6	149 3 14 ·3	3 3 5 ·3
Flora " "	95 31 58 ·1	95 40 33 ·9	10 56 59 ·7
Pallas and Flora,	182 29 47 ·0	180 52 56 ·5	32 16 12 ·2
Hebe " "	155 2 10 ·2	154 40 35 ·4	9 57 20 ·3
Juno " "	197 51 41 ·2	197 16 46 ·6	11 21 17 ·6
Ceres " "	52 57 40 ·6	53 13 47 ·3	6 12 40 ·4
Vesta " "	84 45 34 ·7	84 48 14 ·2	1 29 1 ·4
Pallas and Vesta,	185 8 5 ·9	183 3 49 ·7	16 21 15 ·5
Hebe " "	163 38 40 ·9	163 6 48 ·6	9 48 11 ·2
Juno " "	203 47 11 ·9	203 1 59 ·4	12 12 52 ·4
Ceres " "	46 10 45 ·8	46 45 59 ·0	4 51 44 ·2
Pallas and Ceres,	190 48 13 ·2	187 28 59 ·8	36 21 42 ·2
Hebe " "	183 49 11 ·9	182 39 37 ·6	12 43 21 ·2
Juno " "	210 34 25 ·0	209 21 21 ·5	16 46 42 ·0
Pallas " Juno,	173 48 39 ·1	173 41 12 ·0	21 35 27 ·6
Hebe " "	76 23 27 ·3	77 16 59 ·5	7 48 43 ·6
Pallas " Hebe,	193 26 36 ·3	190 56 32 ·0	23 42 18 ·6

In a paper like this, the influence of the perturbations is of course, not to be considered;—still less the mutual action of the asteroids upon one another. Be it allowed me here, however, to express my belief that in future calculations this influence cannot always be neglected.

Should, at any future time, as is by no means impossible, two of those coupled in the following table, approach the node at the same time, their mutual action must, in spite of their excessively small mass, be extremely strong.

Such an occurrence is for Ceres and Pallas and for similar pairs, where the periods of revolution are very nearly equal, not so probable as for such pairs as Flora and Astræa, whose periods of revolution differ by $317\frac{1}{2}$ days and which revolve, moreover, in planes inclined to another by a small angle.

The following are those nodes at which the asteroid orbits are at a less distance from one another than one-fifth of the mean radius-vector of the earth, and where, as before, the first mentioned orbit is referred to the other.

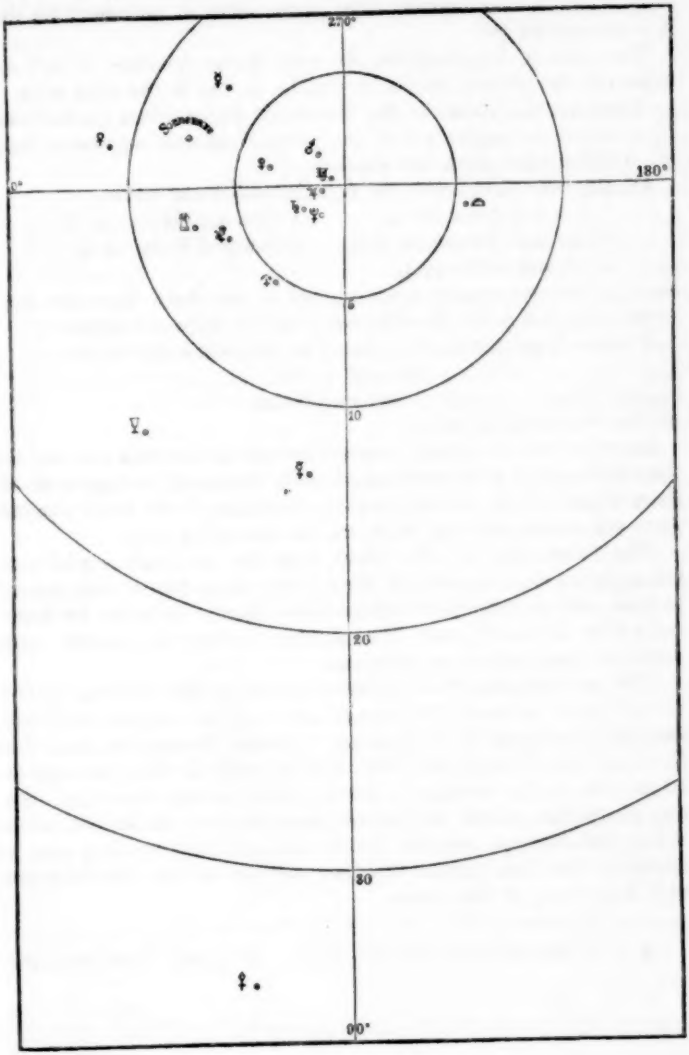
Distance of the orbits.

	Asc. Node.	Desc. Node.
Pallas and Astræa,	0·12	0·11
Juno " "		0 11
Ceres " "		0·19
Flora " "		0·04
Hebe " Iris,		0·14
Juno " "	0·11	
Ceres " "		0·11
Vesta " "	0·04	
Flora " "	0·02	
Pallas " Flora,	0·13	
Hebe " "		0·03
Pallas " Vesta,	0·10	
Pallas " Ceres,	0·19	
Hebe " Juno,	0·10	

The shortness of the period in which Astræa and Flora complete each an integral number of revolutions (nineteen revolutions of Flora are very nearly equal to fifteen of Astræa), renders such an approach to one another in the vicinity of the above mentioned node, by no means improbable. Indeed if the elements of both planets could at present be considered as sufficiently accurate, it would be very easy to name a not very distant epoch, at which this must happen.

A somewhat similar relation is that of Iris and Hebe to Flora, and of Iris to Vesta, in the descending nodes. The periods of revolution are in the case of Iris and Vesta, very nearly equal—on the other hand the mutual inclination of the two orbits is very small.

The periods of Iris and Flora are to one another, nearly as 9 to 8, of Hebe and Flora, nearly as 15 to 13. Here however


270°
0°
180°
10
20
30
90°

the inclination is in both cases quite considerable, so that these must approach much nearer to their common node in order that such a mutual action may take place, than is necessary for the first mentioned pair.

The table of longitudes in the orbit shows whether at such an approach the planets would be visible, or lost in the solar rays.

Although the planes of the Vesta and Flora orbits are inclined by so small an angle, yet at the point of nearest approach they are 0·222 distant from one another.

On the other hand we find that the following orbits,

Iris and Astræa in ☊ Pallas and Hebe in ♉
Hebe and Astræa in ♉ Ceres and Hebe in ☊
Juno and Vesta in ☊

are at a distance nearly equal to that of the earth from the sun, —*but that this is for the different orbits in different nodes.*

Farther from one another than the astronomical unit are,

Iris and Pallas,
Flora and Pallas,

in their descending nodes.

In order to give a still clearer view of the situation of the asteroidal orbits, I have stereographically projected the poles of all these planes of the several planet-orbits and of the sun's equator upon the accompanying chart, on the preceding page.

The observation of Dr. Olbers that the asteroids varied considerably in the intensity of their light, from day to day, seems to hold also for the newly discovered ones. In order to determine this definitely, and if confirmed to find the periods, long series of observations are requisite.

The investigations* of Gauss concerning the Zodiacs of the planets have rendered it comparatively easy to compute for every asteroid, the limits of its geocentric places. Gauss has done this for Ceres and Pallas,† and Prof. Goldschmidt for Iris,‡ and calculators will not be wanting to do the same for the other five. By this means the search for former observations is facilitated, since it has thus become possible, in the case of every missing star, to decide at the first glance whether any one of the asteroids can ever have been in that place.

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* M. C., x, 173. Ast. Nach., xxvi, No. 614 (?) † M. C., ibid. ‡ Ast. Nach., ibid.

Art. IV.—*Continuation of the List of Localities of Algæ in the United States;* by Prof. J. W. Bailey.

(Continued from vol. iii, ii Ser., p. 403.)

Deferring for the present, a list of American Desmidiaceæ and select Diatomaceæ or Bacillariæ with which I intended to complete this paper, I proceed to give the following catalogue of genuine Algæ, localities of which have been recently discovered in the United States.

For some of the most interesting species I am indebted to Prof. Lewis R. Gibbes of Charleston College, South Carolina, who, in addition to some fine Algæ, collected by himself in Charleston Harbor, gave me a most valuable collection made at Key West, Florida, by Dr. F. Wurdemann.

The Algæ from Key West are generally so different from those of the Northern Atlantic, which I have hitherto chiefly studied, that I determined to submit them to the examination of the distinguished British Algologist, W. H. Harvey of Trinity College, Dublin, who by means of his extensive Herbarium and great familiarity with the Algæ of all parts of the world, could easily determine the proper position of the species which to me appeared new or doubtful. To this gentleman I am greatly indebted for his liberal communication of information, relating to many of our Algæ which, for want of standard collections in this country, I was unable to determine satisfactorily.

I am also indebted to the eminent French Algologist, Dr. Montagne, for interesting remarks upon some specimens which I sent to him.

A few additional localities are given of plants already included in the preceding portions of this list.

Melanospermeæ.

Sargassum vulgare, Ag. Key West, Florida. Dr. F. Wurdemann.

Padina Pavonia, Lamour., fine specimens. Key West.

Dictyota ciliata, J. Ag. Key West. Fine specimens.

Dictyota linearis? Key West.

Ectocarpus viridis, Harv. mss. Charleston, S. C. "Not in fruit and therefore a doubtful species, but its color very remarkable." Harv.

Ectocarpus fasiculatus, Harv. Rhode Island. Common.

Ectocarpus littoralis, Lyngb. New Brighton, Staten Island.

Chordaria divaricata, Harv. Stonington, Conn. Fine specimens near the light-house.

RHODOSPERMEÆ.

Rhodymenia cristata, Grev. Massachusetts Bay. Fine specimens of this interesting plant were given me by Miss Saltonstall of Salem, Mass. It has been found also at Newport and Staten Island, while in the Eastern Atlantic, according to Harvey, it is not found south of the Orkney Islands.

Amansia multifida, Lamour. Key West.

Laurencia obtusa, Lamour. Key West.

Laurencia pinnatifida, Lamour. Key West.

Laurencia Baileyanum, Mont. in litt. I had supposed this to be a variety of *L. dasyphylla*, but Dr. Montagne, to whom I sent some specimens of it, pronounces it new, and gives the following as its specific characters.

"*L. Baileyanum*, Mont. Fronde elongata filiformi subsimplici, ramentis subternis lineari-lanceolatis utrinque attenuatis erectis obsessa. (Individuum tetrasporophorum)." He adds, that "notwithstanding the close affinity of this Alga to *Laurencia tenuissima* and to *L. dasyphylla*, it cannot be confounded with either of them. The absence of ramification distinguishes it sufficiently from the first, and the form of the ramenta does not permit it to be referred to the second, from which it is in other respects quite distinct."

It occurs at Newport, R. I., Stonington, Conn., and Fort Hamilton, N. Y.

Hypnea robusta, Harv. MSS. "A fine species quite new to me." Harv. Key West.

Hypnea musciformis, Lamour. Key West.

Ceramium clavulatum, Ag. Abundant at Key West.

Ceramium fastigiatum, Harv. Common at Newport, R. I., and Fort Hamilton, N. Y.

Callithamnion Baileyi, Harv. MSS. "A distinct and beautiful species." Harv. Abundant at Fort Hamilton and New Brighton, N. Y.

Callithamnion arachnoideum, Ag. Rhode Island.

Alsidium triangulare, J. Ag. Key West.

Polysiphonia (Alsidium?) *Gibbesii*, Harv. MSS. Key West. "A very remarkable plant." Harv.

Polysiphonia breviarticulata, Ag. "A Mediterranean species, the Florida specimens very similar to the European but smaller." Harv.

Polysiphonia variegata, Ag. Very fine specimens near the light-house at Stonington, Conn.

Polysiphonia nigrescens, Grev. I collected beautiful specimens of a slender variety of this plant at New Brighton, N. Y.

Polysiphonia Harveyi, Bailey. A distinct and beautiful species which I found growing in considerable quantity on leaves

of Zostera at Stonington, Conn. Its habit distinguishes it at a glance from all other species, yet it is difficult to frame a description of it which will serve to characterize it; the following, however, are some of its principal characters. Frond two to four inches, rising by a single filament from a spreading root and almost immediately giving off one or more robust branches. These in their turn give off, at irregular intervals, long branches which are beset with short robust ramuli, the ultimate divisions of which are acute cones, at the apices of which a few slender fibres are attached. The plant is articulated throughout. Its color when fresh is reddish brown, when dry it appears nearly black. The fruit has not yet been observed. I take peculiar pleasure in making use of this beautiful plant to associate the name of Harvey with those of the other distinguished Algologists to whom species of Polysiphonia have been dedicated.

Dasya elegans, Ag. Spec. 11, 117 = *D. pedicellata*, Agardh, Syst., 211. To the localities of this beautiful plant previously given, I can now add Charleston, South Carolina, at which place it has been collected by Prof. Gibbes; and Fort Hamilton, New York, where it is very abundant.

Unless I am greatly mistaken, Agardh's *Sphæroccus Torreyi* was founded on a battered specimen of this plant. I judge so from the examination of a fragment of the original specimen still preserved in Dr. Torrey's Herbarium.

Dasya Wurdemanni, Bailey. This species from Key West, which Harvey thinks is new, I would dedicate to Dr. Wurdemann to whom we are indebted for so many fine specimens of the Algæ of Florida.

Spyridia filamentosa, Harv. Key West, also abundant at Stonington, Conn.

Gracilaria dura? Ag. Key West.

Gracilaria Helmintochorton, J. Ag. Key West.

Digenea simplex, Ag. Key West.

Halodictyon sp.? "An imperfectly developed specimen from Key West, the only known species is from the Adriatic." Harv.

Rhodymenia palmata, Grev. A small much divided variety has been collected at Charleston by Prof. Gibbes.

Rhabdonia Baileyi, Harv. MSS. I found this plant several years ago at Staten Island, but for want of fruit-bearing specimens, its proper relations could not be determined. From the examination of dried specimens without fruit, Harvey at first supposed it to be a species of Chrysimenia, but after studying the fructification which I was recently fortunate enough to detect on specimens at Fort Hamilton, N. Y., and which I sent to him preserved in Goadby's solution, he was enabled to determine its true characters. He says, "It is not a Chrysimenia, the fruit and structure being that of the *Cryptonemeæ*, not *Chondrieæ*. Oddly

enough it agrees in structure with some Algæ from Van Diemens Land, on which I lately founded the genus Rhabdonia. The *tetraspores* only of the Tasmanian species are known, and the American specimen has only *favellidia*. The tetraspores ought to be ellipsoidal, divided by transverse rings, and to occur dispersed through the smaller branches."—Very fine specimens of this plant with abundance of fruit may be found in July, near Fort Hamilton and Bath, Long Island, N. Y.

Chondrus Brodiæi, Grev. Newport, R. I.

Chondrus Norvegicus, Lamour. Massachusetts Bay. G. B. Emerson.

Ptilota plumosa, Ag. Very fine specimens of variety α, have been given me by Miss Saltonstall of Salem, who collected them in Massachusetts Bay. At Newport I could only find variety β, which is a much less elegant plant.

Corallina officinalis, Linn. Very abundant on shores of New England.

A number of species of *Corallineæ* collected at Key West by Dr. Wurdemann were presented to me by Prof. Gibbes, but as it is only recently that the vegetable nature of these bodies has been established, few of them are included in Algological works, and the determination of the species is attended with much difficulty; I hope, however, to present, at some future time, a list of our North American species.

Chlorospermeæ.

Dasycladus clavæformis, Ag. Key West.

Acetabularia crenulata, Lamour. Key West. Common.

Conferva melagonium, Web. et Mohr. Near Beverly, Mass. Dr. Asa Gray!

Cladophora prolifera. Key West.

Cladophora prasina, Harv. mss. "Its recent affinity is to *C. rupestris*." Harv. Abundant on rocks below low water mark in the Hudson River at West Point.

Caulerpa concinna, Harv. mss. Key West. "A most charming new species, allied to *C. Webbiana*, Mont., but very distinct. Most of the species are tropical." Harv.

Anadyomene flabellata, Ag. Key West. Rather common.

Ulva latissima, Linn. Key West.

Dictyosphæria favulosa, Decaisne. Key West.

Bryopsis plumosa, Ag. New Brighton, N. Y., Miss Saltonstall! Charleston, S. C., Prof. L. R. Gibbes!

Ectocarpus viridis, Harv. mss. Charleston, S. C., Prof. Gibbes! "Not in fruit and therefore a doubtful species, but its *color* very remarkable." Harv.

Enteromorpha compressa, Grev. Charleston, S. C. Prof. L. R. Gibbes!

Enteromorpha clathrata, Grev. Staten Island, N. Y.

Porphyra vulgaris, Ag. Charleston, S. C. Staten Island, N. York.

Porphyra laciniata. Fort Hamilton, N. Y.

Gnathum leve, Bailey. I propose this name for a small microscopic plant which I have found growing in considerable abundance as a parasite on stems of Nitella. The whole Alga consists of a single irregular branching layer of green cells, which like those of Coleochæte scutata are closely adherent to the plant on which it grows, but it has no trace of the setiform processes belonging to that species. It appears to grow both by the addition of new cells and the spontaneous division of the old ones. In many of the cells one or more small vesicles, (zoospores?) similar to those in the spiral threads of Zygnema, were observed. No other traces of fruit have been seen. Its place in the systems must be near Coleochæte. Abundant on stems of Nitella, in ponds near West Point, N. Y.

Lyngbya fulva, Harv. MSS. I found this forming erect tufts in small pools of water between high and low-water mark, in cavities of the granite blocks, composing the pier at Stonington, Conn. Whether its color has been affected by exposure to air and sunlight, I cannot say. Harvey says, "I do not know any thing like it."

Lyngbya crispa? Ag. A plant which grows in immense quantities in salt water ditches, near Hoboken. It appears to me to be identical with English specimens marked *L. ferruginea*, Ag., which I received from J. Ralfs, Esq., but Harvey says, "it agrees better with *some* specimens of L. crispa, Ag., under which name, probably more than one species are confounded."

Oscillatoria Friesii? Ag. A common plant forming erect tooth-like fasciles half an inch in height, among mosses on damp ground near West Point. I sent it by the name of *O. Friesii* to Harvey and he remarks concerning it, "this looks different from *O. Friesii*, but comes near it. It is, probably, a different species. But in the fearful confusion that reigns here, I have no fancy for making more names."

Tetraspora lacunosa, Chauv. in Duly. Bot. Gall. I am informed by Dr. Montagne that this is the same as the plant which I had named *T. perforata*, under the supposition that it was an undescribed species.

Lemania Americana, Harv. MSS. This species is founded on an Alga which grows in rivers in Virginia, and which I had supposed to be only a variety of L. fluviatilis, Ag. Harvey remarks that "the European plant is very much more simple with distant nodules, the American one is much branched and quite moniliform."

Hydrodictyon utriculatum, Roth. This plant which is one of the most interesting of the fresh water Algæ, grows abundantly in ditches near the West Point Foundry.

From the above list it appears that the number of species of Algæ now known to occur in the United States, is as follows:

Melanospermeæ, ...	31
Rhodospermeæ, ...	59
Chlorospermeæ, ...	82
or in all, ...	172 species,

exclusive of Byssoideæ, Desmidiaceæ and Diatomaceæ. When it is considered that the study of our Algæ has as yet hardly commenced, it is reasonable to expect that very large additions will be made by further research.

We append to this article by Professor Bailey, a few observations on Algæ and the modes of preserving them, taken from "The Dublin University Museum."—Eds.

Directions for Collecting and Preserving Algæ; by Dr. Wm. H. Harvey.

(From a Report by the Directors of the Dublin University Museum.)

"*General Character of the Algæ.*—The *Algæ* may, for popular purposes, be divided into *four* principal groups, viz.:—

"1. Fuci, or *Olive-colored Sea-weeds*, which are generally of large size, and leathery texture; sometimes membranaceous and leafy, and more rarely of a gelatinous or filamentous nature.

"2. Florideæ, or *Red-colored Sea-weeds;* cartilaginous and fleshy, membranous or gelatinous sea-weeds; often filamentous; of a red, purple, brown-red, or livid greenish-red color.

"3. Chlorosperms, or *Green Sea-weeds;* membranaceous or filamentous; rarely somewhat horny plants, of a green color and simple structure.

"4. Corallines; vegetables coated with a crustaceous epidermis composed of carbonate of lime, either red or green when fresh, becoming white and often brittle on exposure to the air. (These must not be confounded with the true *zoophytes*, which often assume the appearance of plants.)

"*Places of Growth, and Mode of Collecting.*—The *Algæ* are found, in greater or less abundance, from the extreme of high-water mark to the depth of from thirty to fifty fathoms. Those within the reach of the tide are to be collected at low water, especially of *spring tides*, the most interesting species growing frequently at the verge of low-water mark, either along the margin of rocks partially laid bare, or, more frequently, fringing the deep

tide-pools left by the recess of the tide on a flattish rocky shore. Those which grow at a greater depth than the tide exposes, must be sought by *dredging*, or by dragging after a boat an iron cross furnished with numerous strong hooks, on all shores where such contrivances can be applied; but where dredging for deep-water plants is impossible, the collector must trust to finding his *desiderata* among the heaps of weed thrown up on flat shores after a gale. Even after ordinary tides many delicate species float ashore, and may be collected along the beach in a perfect state. Therefore, after visiting the more rocky places at low water, the sandy or shingly beach should always be inspected at the return of the tide. In collecting from heaps, care should be taken to select those specimens which have suffered least in color, &c., from exposure to the air, rejecting those that are *bleached* white.

"Collectors should be provided with one or two strong glass bottles with wide mouths, or with a hand basket lined with japanned tin, for the purpose of bringing home the smaller and more delicate species in *sea water*. This precaution is often absolutely necessary, many of the filamentous *florideæ* decomposing with rapidity if exposed, even for a short time, to the sun and air, or if allowed, to become massed together with plants of a coarser texture. All these delicate kinds,—to distinguish which can only be learned by experience,—must be brought home in sea water, and kept in it until they can be arranged for drying.

"A common vasculum, a basket, or a bag, will serve to bring home the larger and less delicate kinds; but even these should not be left so long unsorted as to allow of their becoming clotted together.

"In collecting algæ from their native places of growth, great care should be taken to pluck the whole plant from the very base, and, if it have an obvious root, to gather the specimen with its root attached. This is of much importance, and apt to be neglected by young collectors, who are satisfied with plucking branches or scraps, which often afford no just notions of the mode of growth, or natural habit of the plant from which they have been plucked, and which, in many cases, are wholly insufficient for the first purpose of a specimen, that of ascertaining its position in the system. In many of the leafy *fuci* (*sargassa*) the leaves which grow on the lower and on the upper branches are quite different; and were a lower and an upper branch to be plucked from the same individual, they might pass for portions of different species. It becomes of moment, therefore, to gather, when it can be done, the *whole plant, including the root.* It is true that the larger kinds may be *judiciously* divided; but the young collector had better aim at selecting moderate sized specimens of the entire plant, than attempt the division of large specimens, unless he keep in view that *every specimen should be an*

epitome of the essential characters of a species. Several duplicates of every species should be collected.

"*Preserving Specimens of Algæ.*—Where it is a collector's object to preserve algæ in the least troublesome manner, for the purpose of transmitting them to Europe, it is merely necessary to spread the specimens, immediately on being brought fresh from the sea, without any previous washing, and even without squeezing their natural moisture from them, in an airy situation, as hay is spread out to dry, only they must not be exposed to too powerful a sun. In dry weather, if the layer be turned over a few times, they will very rapidly dry, and no other preparation is necessary. They will have shrunk considerably, and many will have darkened in color, and the bundle may have become very unsightly; nevertheless, if *thoroughly* dried (to prevent mouldiness or heating), and packed loosely in paper bags or rough boxes, such specimens will, generally speaking, reach Europe after many months, in a perfectly sound state; and, on being re-moistened and properly pressed, will make excellent cabinet specimens. It is very much better, when drying algæ in this rough manner, *not* to wash them in fresh water, because the salt they contain serves the double purpose of preserving them, and of keeping them in a pliable state, causing them to imbibe water on re-immersion more readily. Washed algæ, roughly dried, become very hard and unmanageble. I would recommend that all the larger and coarser kinds of algæ, sent from abroad, be preserved in this manner. With the more delicate and smaller kinds, a different course may be pursued.

"*Preserving delicate Algæ.*—Small, filamentous, and gelatinous algæ cannot be well preserved in the rough manner just described, and, when practicable, should be put up, after gathering, on the papers on which they are intended to remain. With a little care, and after a few trials, the mode of preparing them will be easily learned.

"The collector should have two or three flat dishes, one of which is to be filled with salt water and two with fresh; in the first of these the specimens are to be rinsed and pruned, to get rid of any dirt or parasites, or other extraneous matter; they are then to be floated in one of the dishes of fresh water for a few minutes, care being taken not to leave them too long in this medium, and then one by one removed to the third dish, and a piece of white paper, of the size suited to the size of each specimen, is to be introduced underneath it. The paper is to be carefully brought to the surface of the water, the specimen remaining displayed upon it, with the help of a pair of forceps or a porcupine's quill, or any fine-pointed instrument, and it is then to be gently drawn out of the water, keeping the specimen displayed. These wet papers, with their specimens, are then placed between sheets

of soft soaking-paper, and put under pressure, and in most cases the specimen in drying adheres to the paper on which it is laid out. Care must be taken to prevent the blotting-paper sticking to the specimens and destroying them. Frequent changes of drying-paper (once in six hours), and cotton rags laid over the specimens, are the best preservatives. The collector should have at hand four or five dozen pieces of unglazed thin calico [white muslin] (such as costs five or six cents a yard), each piece about eighteen inches long and twelve wide, one of which, with two or three sheets of paper, should be laid over every sheet of specimens as it is put in the press. These cloths are only required in the first two or three changes of drying-papers, for, once the specimen has begun to dry, it will adhere to the paper on which it has been floated, in preference to the blotting-paper laid over it. Should it perversely adhere to the calico, it is better not to attempt to detach it till it is nearly dry, when by a little care it may generally be got free. Algæ do not take so long to dry as other plants, and many, in warm weather, will be found to be sufficiently dried after forty-eight hours, if the papers have been changed three or four times.

"*Corallines, and Sponges*, require no trouble when once collected; it is merely necessary to dry them roughly, and pack them among the rough-dried sea-weeds in boxes. As much interest attaches to these productions, and as those of tropical and sub-tropical countries are still very imperfectly known to naturalists, collectors of algæ are earnestly requested to secure them whenever they present themselves."

ART. V.—*Objections to the Theories severally of Franklin, Dufay and Ampère, with an Effort to Explain Electrical Phenomena by Statical or Undulatory Polarization;* by ROBERT HARE, M.D., Emeritus Professor of Chemistry in the University of Pennsylvania.

(Continued from ii Ser., vol. v, p. 351.)

Process by which the Ethereo-ponderable Atoms within a Galvanic Circuit are polarized by the Chemical Reaction.

58. In order that an ethereo-ponderable particle of oxygen in any aqueous solution shall unite with an ethereo-ponderable particle of zinc in a galvanic pair, there must be a partial revolution of the whole row of ethereo-ponderable zinc atoms, with which the atom assailed is catenated by the attractions between dissimilar poles. Moreover, at the same time that the metallic atoms are thus affected, the atoms of water between the metallic sur-

faces must undergo a similar movement, by an analogous reaction with poles of an opposite character, and this movement must extend through the negative plate to the conductor, by which it communicates with the zinc or electro-positive plate. When the circuit is open, the power of combination exercised by the zinc and oxygen is inadequate to produce this movement in the whole chain of atoms, liquid and metallic; but as it is indifferent whether any two atoms are united with each other, or with any other atoms of the same kind, the chemical force easily causes them to exchange partners, as it were, when the whole are made to form a circuitous row in due contiguity.

59. As we know that during their union with oxygen, metals give out an enormous quantity of heat and electricity, it is reasonable to suppose that whenever an atom of oxygen and an atom of zinc jump into union with each other, a wave is induced in the ethereo-ponderable matter, and that this wave is sustained by the decompositions and recompositions by means of which an atom of hydrogen is evolved, at the negative plate and probably enabled to assume the aëriform state. There must, at the same time, be a communication of wave polarity by contact of the negative plate with the connecting wire, by which the positive wave in the wire is induced. Although the inherent polarities of the metals are not, agreeably to this view, the moving power in galvanism, yet they facilitate, and in some cases induce the exercise of that power, by enabling it to act at a distance, when otherwise it might remain inert.

60. This, I conceive is shown in the effect of platina sponge upon a mixture of the gaseous elements of water; also in Grove's *gas* battery, by means of which hydrogen and oxygen gas severally react with water in syphons, so as to cause each other to condense, without any communication besides that through the platina, and an electrolytic decomposition and recomposition extending from one of the aqueous surfaces in contact with one of the gases, to the other surface in contact with the other gas.

Difference between Electro-ethereal and Ethereo-ponderable Polarization.

61. There are two species of electro-polarity which come under the head of statical electricity. One of these Faraday illustrates by supposing three bodies, A, B and C, in proximity, but not in contact, when A, being electrified, electrifies B, and B electrifies C by induction. This Faraday calls an *action* of the particles of the bodies concerned, whereas, by his own premises, it appears to me to be merely a superficial affection of the masses or of a circumambient ethereal matter. This species of polarization, to which the insulating power of air is necessary, affects the superficies of a body only, being displayed as well by a gilt

globe of glass, as a solid globe of metal. No sensible change appears to be produced in the ponderable conducting superficies by this inductive superficial electrification of masses; and of course no magnetism.

62. When a small image, of which the scalp has been abundantly furnished with long hair, is electrified, the hairy filaments extend themselves and move apart, as if actuated by a repulsive power: also when iron filings are so managed as to obey the influence of the poles of a powerful magnet (51), they arrange themselves in a manner resembling that of the electrified hair. There is, moreover, this additional analogy, that there is an attraction between two portions of hair differently electrified, like that which arises between filings differently magnetized. Yet the properties of the electrified hair and magnetized filings are, in some respects, utterly dissimilar. A conducting communication between differently electrified portions of hair would entirely neutralize the respective electrical states; so that all the electrical phenomena displayed by them would cease. Yet such a communication made between the poles, exciting the filings, by any non-magnetic conductor, does not in the slightest degree lessen their polar affections and consequent power of reciprocal influence. Upon the electrified hair, the proximity or the contact of a steel magnet has no more effect than would result under like circumstances from any other metallic mass similarly employed; but by the approximation, and still more, the contact, of such a magnet, the affection of the filings may be enhanced, lessened, or nullified, according to the mode of its employment. In the case of the hair, the affection is superficial, and the requisite charging power must be in proportion to the extent of surface. In the case of the magnetized ferruginous particles, it is the mass which is affected, and, cæteris paribus, the more metal, the greater the capacity for magnetic power. In the instance of the electrified hair, as in every other of frictional excitement, the electrical power resides in imponderable ethereo-electric atmospheres which adhere superficially to the masses, being liable to be unequally distributed upon them in opposite states of polarity, consequent to a superficial polarization of the exciting or excited ponderable masses; but in the instance of bodies permanently magnetic, or those rendered transiently magnetic by galvanic influence, the ethereo-electric matter and the ponderable atoms are inferred to be in a state of combination, forming ethereo-ponderable atoms; so that both may become parties to the movements and affections of which the positive and negative waves consist.

63. Thus an explanation is afforded of the hitherto mysterious diversity of the powers of a gold leaf electroscope and galvanoscopes, although both are to a wonderful degree sensitive; the latter to the most feeble galvanic discharge, the former to the

slightest statical excitement; yet neither is in the most minute degree affected by the polarization which affects the other.

64. The charge which may exist in a coated pane affords another exemplification of statical or electro-ethereal polarity. In this case, according to Faraday, the particles of glass are thrown into a state of electro-polarity, and are, in fact, partially affected as if they belonged to a conductor; so that insulators and conductors differ only in the possession in a high degree by the one, of a susceptibility of which the other is possessed to an extent barely perceptible. The facts seem to me only to show, that either an insulator or conductor may be both affected by the same polarizing force, the transmission of which the one facilitates, the other prevents. I am under the impression that it is only by the diruptive process that electricity passes through glass; of course involving a fracture. It gets through a pane or jar, not by aid of the vitreous particles, but in despite of their opposing coherence. The glass in such cases is not liable to be fused, deflagrated, or dissipated, as conductors are. It is forced out of the way of the electrical waves, being incapable of becoming a party to them. Discharges will take place through a vacuity, rather than through the thinnest leaf of mica. But if, as Faraday has alleged, from within a glass flask hermetically sealed, an electrical charge has been found to escape, after a long time, it proves only that glass is not a perfect insulator, *not that perfect insulation and perfect conduction are different extremes of the same property.* On the contrary, the one is founded upon a constitution competent to the propagation within it of the electro-polarizing waves, with miraculous facility, while the other is founded either on an absolute incapacity, or comparatively an infinitely small ability to be the medium of their conveyance. The one extremely retards, the other excessively expedites its passage through a space otherwise void.*

Competency of a Wire to convey a Galvanic Discharge is as its sectional area, while statical discharges of frictional electricity preferring the surface are promoted by its extension. Yet in proportion as such discharges are heavy, the ability of a wire to convey them and its magnetic energy become more dependent on its sectional area and less upon extent of surface.

65. Reference has been made to two modes of electrical conduction, in one of which the efficacy is as the surface; in the other, as the area of a section of the conductor. Although glass be substantially a non-conductor, the power of the surface of glass when moistened, or gilt, to discharge statical electricity,

* By a void, I mean a Torricellian vacuum. The omnipresence of the electro-ether must render the existence of a perfect void impossible.

is enormous. It has been generally considered, that as a protection against lightning, the same weight of metal employed as a pipe, would be more efficacious than in the usual solid form of a lightning rod: yet this law does not hold good with respect to galvanic discharges, which are not expedited by a mere extension of conducting surface. Independently of the augmentation of conducting power, consequent to radiation and contact with the air, the cooling influence of which, according to Davy, promotes galvano-electric conduction, a metallic ribbon does not convey a galvanic discharge better than a wire of similar weight and length.*

66. Agreeably to the considerations above stated, the sectional area of a conductor remaining the same, in proportion as any *statical* accumulation which it may discharge is greater, the effects are less superficial; and the ethereo-ponderable atoms are affected more analogously to those exposed to galvanic discharges. It is in this way that the discharge of a Leyden jar imparts magnetic polarization. Thus, on the one hand, the electro-ethereal matter being polarized and greatly condensed, combines with and communicates polarization, and consequently magnetism, to ethereo-ponderable bodies; while, on the other hand, these, when polarized by galvanic reaction, and thus rendered magnetic, communicate polarity to the electro-ether. Hence statical electricity, when produced by galvanism, and magnetism, when produced by statical electricity, are secondary effects.

67. Where a wire is of such dimensions, in proportion to the charge, as to be heated, ignited, or dispersed by statical electricity, there seems to be a transitory concentration of the electric power, which transforms the nature of the reaction, and an internal wave of electro-ponderable polarization, similar to those of galvano-electricity, is the consequence.

68. As above observed, (31,) the current produced by the magneto-electric machine, has all the attributes of the galvano-electric current; yet this is altogether a secondary effect of the changes of polarity in a keeper, acting upon a wire solely by dynamic induction. But if, by mere external influence, the machine above mentioned can produce within a circuit a current such as above described, is it unreasonable to suppose that the common machine, when it acts upon a circuit, may put into activity the matter existing therein, so as to produce waves of polarization,

* It is well known that Wollaston effected the decomposition of water by the aid of a powerful electrical machine. Having enclosed platina wires within glass tubes, these were fused so as to cover the ends. The glass was afterwards so far removed, by grinding, as to expose minute metallic points to the liquid. Under these circumstances, the electricity conveyed by the wires, being prevented from proceeding over them superficially, was obliged to make its way through the ethereo-ponderable matter of which metals consist (38). Instead of proving the identity of galvanism with frictional electricity (note 39), this experiment shows that in one characteristic at least there is a discordancy. At the same time it may indicate that ethereal may give rise to ethereo-ponderable undulations.

having the power of those usually ascribed to a galvano-electrical current?

69. It has been shown that both reason, and the researches and suggestions of Faraday, warrant the inference that ponderable atoms, in solids and liquids, may be considered as swimming in an enormous quantity of condensed imponderable matter, in which all the particles, whether ponderable or imponderable, are, in their natural state, held in a certain relative position due to the reciprocal attraction of their dissimilar poles. A galvano-electrified body differs from one in its ordinary state, in having the relative position of the poles of its ethereo-ponderable atoms, so changed, that their inherent opposite polarities not being productive of reciprocal neutralization, a reaction with external bodies ensues.

70. In statical excitement the affection is superficial as respects the ponderable bodies concerned, while in dynamic excitement the polarities of the whole mass are deranged oppositely at opposite ends of the electrified mass; so that the oppositely disturbing impulses, proceeding from the poles of the disturbing apparatus, neutralize each other intermediately. Supposing the ponderable as well as the imponderable matter in a perfect conductor, to be susceptible of the polar derangement, of which an electrified state is thus represented to consist, non-conductors to be insusceptible of such polar derangement; imperfect conductors may have a constitution intermediate between metals and electrics. When an electrical discharge is made through any space devoid of air or other matter, it must then find its way solely by the polarization of the rare imponderable matter existing therein; and consequently its coruscations should be proportionably more diffuse, which is actually found to be true; but when gaseous ethereo-ponderable atoms intervene, they enable competent waves to exist within a narrower channel, and to attain a greater intensity. I consider all bodies as insulators which cause discharges through them to be more difficult than through a vacuum, and which, by their interposition within a circuit, can prevent that propagation of the oppositely polarizing undulations which would otherwise ensue. This furnishes a good means of discrimination between insulators and conductors, the criterion being, that a discharge ensues more readily as there is more of the one and less of the other in the way: that the one leads the waves where they would not go, the other impedes their going where they would proceed. Both in the case of diruptive discharge through air, producing a spark, or of a deflagrating discharge through wire, causing its explosion, there is a dispersion of intervening ponderable particles; and yet there is this manifest discordancy, that in one case the undulatory process of transfer is assisted, in the other resisted. The waves follow

the metallic filament with intense attraction, while they strive to get out of the way of those formed by the aëriform matter, as if repelled. Hence the term diruptive, from dirumpo, to break through, was happily employed by Faraday to designate spark discharges. The zigzag form of the diruptive spark, shows that there is a tendency in the aëriform particles to turn the waves out of that straight course, which, if unresisted or facilitated, they would naturally pursue. On the one hand the aërial filaments being unsuitable for the conveyance of the electric waves, these are forced by them out of the normal path, first in one direction, then in another; while on the other hand, the finest metallic filament furnishes a channel for the electric waves, so favorable that this channel is pursued, although the consequent polarization of the conducting particles be so intense as to make them fly asunder with explosive violence. Even when a bell wire has been dissipated by lightning, it has been found to facilitate and determine the path of the discharge.

71. The various forms of the electric spark, resulting from varying the gas through which it may be made to pass, agreeably to the researches of Faraday, is explained by the supposition that the peculiarity of the spark is partially the consequence of the polarizability of the gaseous atoms through which the discharge is made, and varies accordingly in its appearance.

Difference between Frictional Electricity and Galvanic, does not depend on the one being superior as to quantity, the other as to intensity; but on the different degrees in which the Ethereo-ponderable Atoms of the bodies affected, are deranged from their natural state of neutralized Polarity.

72. I infer that all magneto-polar charges are attended by an affection of ponderable particles; and that the reason why the most intense statical charge does not affect a galvanometer, is, that it is only when oppositely excited bodies are neutralized by the interposition of a conductor, as during a discharge, that ethereo-ponderable particles are sufficiently polarized to enable them to act upon others in their vicinity, so as to produce a polar affection the opposite of their own. In this way dynamic induction is consistently explained, by supposing that the waves of polarization, in passing along one conductor, produce, pari passu, the opposite polarization in the proximate part of any neighboring conductor suitably constituted, situated and arranged to allow it to form part of a circuit.

73. It is only during the state of the incessant generation and destruction of what has been called the two electricities, that the circuit, which is the channel for the passage of the polarizing waves, is endowed with electro-magnetic powers. It was, no doubt, in obedience to a perception of this fact, that Oersted ascribed the mag-

netism of a galvanized wire, to a conflict of electricities. Undoubtedly that state of a conductor in which, by being a part of an electrical circuit, it becomes enabled to display electro-magnetic powers, is so far a conflict of the two electricities, as the affections of matter which are denominated electrical, consist of two opposite polar forces, proceeding, agreeably to the language of Faraday, in opposite directions from each side of the source, and conflicting with each other so as to be productive of reciprocal annihilation.

74. That a corpuscular change in conductors is concomitant with their subjection to, or emancipation from, a galvanic current, is proved by an experiment of Henry's, which he afforded me an opportunity, on one occasion, of witnessing. I allude to the fact that sound is produced whenever the circuit is suddenly made or suddenly ruptured. By I. P. Marrian it has been observed, that a similar result takes place during the magnetization or demagnetization of iron rods, by the alternate establishment or arrestation of galvanic discharges through wires coiled about them so as to convert each into an electro-magnet. Mr. Marrian represents the sound as resembling that produced by striking a rod upon one of its ends.*† Sounds from this source were observed by Dr. Page in 1838. This Journal, vol. xxxiii.

75. Thus it appears that there is an analogy between the state of matter which involves permanent magnetism, and that which constitutes a galvanic current, so far as this; that either by one or the other, during either its access or cessation, an affection of the ponderable particles concerned ensues, sufficient to produce sound.

76. Simultaneously with the production of sounds as above stated, by the opening or closing of the galvanic circuit through a metallic rod or the coils of an electro-magnet, secondary waves are induced, called secondary currents. It seems reasonable to ascribe these waves to the same shifting of the poles, which produces the sonorific undulations.‡

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*Agreeably to recent experiments of Faraday, the particles of a glass prism may be so influenced by an electro-magnet as to affect the passage of polarized light.

† L. and E. Phil. Mag. and Jour., vol. xlv, p. 383, 1844.

‡ These phenomena excite more interest in consequence of the employment, for medical purposes, of an apparatus originally contrived by Callan, but since ingeniously modified by our countryman, Dr Page, into a form which has been designated as the electrotome. A coil of coarse copper wire, covered with cotton, like bonnet wire, is wound about a wooden cylinder. Around the coil thus formed, a coil of fine copper wire, similarly covered, is wound, leaving the extremities accessible. One end of the coarse coil communicating constantly with one pole of a galvanic battery, the other end is left free; so that by scraping with it, the teeth of a rasp attached to the other pole, a rapid closing and opening of the circuit may be effected. Under these circumstances, an observer, holding the ends of the fine coil, receives shocks more or less severe, according to the construction of the battery, the energy of the agents employed to excite it, or the total weight and

77. Within the bodies of animals and vegetables, the electro-ether may be supposed to exist as an atmosphere surrounding the ethereo-ponderable atoms of which their organs are constituted, so as to occupy all the space which is not replete with such atoms. Hence a discharge of frictional electricity may indirectly polarize the whole animal frame, by producing ethereo-ponderable polarization in the constituent atoms of the fibres of the nerves and muscles. Probably this polarization is produced more immediately in the ponderable solids, by a discharge from a vol-

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relative dimensions of the coils, as to length and sectional area. Agreeably to the received doctrine, the shocks thus produced, are owing to secondary currents caused by dynamic induction. Agreeably to the hypothesis which I have advanced, the atoms of the coarse wire, polarized by waves proceeding from the poles of the battery, induce a corresponding polarization of the atoms of the fine wire; the aggregate polarity imparted, being as the number of atoms in the former, to the number of atoms in the latter; or, (to use an equivalent ratio,) as the weight of the coarse, to the weight of the fine wire. But as on breaking the circuit, through the coarse wire, the ethereo-ponderable atoms in both wires resume their neutral positions, while this requires each circuit to be run through within the same minute interval, the velocities of their respective waves will be inversely as their sectional areas and directly as their lengths: in other words, the velocity in the fine wire, will be as much greater, as the channel which it affords is narrower and longer. The cylinder, included within the coils as above stated, being removed; a cylindrical space is vacated. If into the cavity thus made, iron rods, like knitting needles, be introduced, one after the other, while the apparatus is in operation, the shocks increase in severity as the number augments: so that from being supportable, they may be rendered intolerable. The shock takes place without the presence of iron, but is much increased by its assistance.*

These facts appear to me to justify a surmise, that the ethereo-ponderable atoms of iron, in becoming magnetized and demagnetized, coöperate with the ethereo-ponderable atoms of the copper coils in the induction of secondary undulations. It is conceived that these may be owing to the intestinal change, attended by sound, as above stated (73); this being caused by a sudden approximation of the poles of the atoms, previously moved apart by the influence of the galvanized coil. But if this sudden coming together of the previously separated poles of atoms within a magnetized cylinder of iron, can contribute to the energy of secondary waves, it is consistent to infer that these waves owe their origin to an analogous approximation of the separated poles of the cupreous atoms, forming the finer coil, in which the secondary undulations may be created without the presence of iron. Of course this reasoning will apply to all cases in which the phenomena hitherto attributed to Faradian currents are the result of dynamic induction.

Thus it appears that the polarization of magnets, and that created and sustained when a galvanized coil or helix acts upon another in proximity, have the same relation to galvanic discharges that the charges upon insulated surfaces have to their appropriate discharges. The permanent magnetism of steel seems to have some analogy with the charge upon a coated pane, while we may consider as analogous with the charges upon insulated conductors, already adverted to (61, 62), that state of the ethereo-ponderable particles (38) of a wire helix, which *state*, resulting from the influence of an included magnet, or neighboring galvanized coil, and being discharged on a change of relative position, or breach of the galvanizing circuit, is productive of spark, shock, ignition, or electrolysis, as exemplified by Callan's coil, Page's electrotome, or the magneto-electric machine.

* Agreeably to the usual construction, the cylinder about which the inner coarse wire coil is wound, is originally of iron, so that there is as much of this metal contained as it can hold. Various contrivances are resorted to for the closing and opening of the circuit, which are more ingenious and convenient than scraping a rasp, as above described.

taic series, or a wire subjected to electro or magneto-dynamic induction. In the latter instances the shock is reiterated so rapidly as to appear more enduring, while in the former, it is more startling and producible at an infinitely greater distance.

78. Agreeably to Faraday's researches (1485 to 1543), there is reason to suppose that in frictional spark discharges, the consequent shock, light, and other peculiarities, are in part owing to waves of ethereo-ponderable polarization, indirectly produced in the intervening gaseous matter. (71.)

Of Ethereo-ponderable Deflagration.

79. It is well known, that between two pieces of charcoal attached, one to the negative, the other to the positive pole of a numerous and well excited voltaic series, an arch of flame may be produced by moving them apart after contact. This phenomenon evidently depends upon the volatilization of the ponderable matter concerned; since it cannot be produced before the carbon has been volatilized by contact, nor by any body besides charcoal, this being the only conductor which is sufficiently infusible, and yet duly volatilizable. Metals, similarly treated, fuse at the point of contact and cohere. On separation, after touching, a single spark ensues; which, without repetition of contact, cannot be reproduced. Hence, it may be inferred, that the carbonaceous vapor is indispensable to this process, as a medium for the ethereo-ponderable polarizing waves, being soon consumed by the surrounding atmospheric oxygen. The excrescence upon the negative charcoal, observed by Silliman, together with the opposite appearance on the positive charcoal, may be owing to the lesser affinity for oxygen on the negative side.*

80. There may be some resemblance imagined between this luminous discharge between the poles, and that which has already been designated as diruptive (69); but this flaming arch discharge does not break through the air, it only usurps its place gradually, and then sustains this usurpation. It differs from the other as to its cause, so far as galvanic reaction differs from friction; moreover, it requires a volatilizable, as well as a polarizable ponderable conducting substance to enable its appropriate undulations to meet at a mean distance from the solid polar terminations, whence they respectively proceed.

81. The most appropriate designation of the phenomenon under consideration, is that of ethereo-ponderable undulatory deflagration. Under this head, we not only place the flaming arch, but likewise the active ignition and dissipation of fine wire or leaf metal, or when attached to one pole, and made barely to touch the other.

* American Journal of Science, vol. x, p. 121, 1826.

82. In one of Faraday's experiments, a circuit was completed by subjecting platinum points, severally proceeding from the poles of a voltaic series, while very near to each other, to the flame of a spirit lamp. This was ascribed by him to the rarefaction of the air, but ought, as I think, to be attributed to the polarizable ethereo-ponderable matter of the flame, performing the same office as the volatilized carbon in the flaming arch, between charcoal points, to which reference has been made.

Summary.—From the facts and reasoning which have been above stated, it is presumed that the following deductions may be considered as highly probable, if not altogether susceptible of demonstration.

The theories of Franklin, Dufay and Ampère, are irreconcilable with the premises on which they are founded, and with facts on all sides admitted.

A charge of frictional electricity, or that species of electric excitement which is produced by friction, is not due to any accumulation, nor to any deficiency either of one or of two fluids, but to the opposite polarities induced in imponderable ethereal matter existing throughout space however otherwise void, and likewise condensed more or less within ponderable bodies, so as to enter into combination with their particles, forming atoms which may be designated as ethereo-ponderable.

Frictional charges of electricity seek the surfaces of bodies to which they may be imparted, without sensibly affecting the ethereo-ponderable matter of which they consist.

When surfaces thus oppositely charged, or, in other words, having about them oppositely polarized ethereal atmospheres, are made to communicate, no current takes place, nor any transfer of the polarized matter: yet any conductor touching both atmospheres, furnishes a channel through which the opposite polarities are reciprocally neutralized by being communicated wave-like to an intermediate point.

Galvano-electric discharges are likewise effected by waves of opposite polarization, without any flow of matter meriting to be called a current.

But such waves are not propagated superficially through the purely ethereal medium; they occur in masses formed both of the ethereal and ponderable matter. If the generation of frictional electricity, sufficient to influence the gold leaf electrometer, indicate that there are some purely ethereal waves caused by the galvano-electric reaction, such waves arise from the inductive influence of those created in the ethereo-ponderable matter.

When the intensity of a frictional discharge is increased beyond a certain point, the wire remaining the same, its powers become enfeebled or destroyed by ignition, and ultimately deflagration:

if the diameter of the wire be increased, the surface, proportionally augmented, enables more of the ethereal waves to pass superficially, producing proportionally less ethereo-ponderable undulation.

Magnetism, when stationary, as in magnetic needles and other permanent magnets, appears to be owing to an enduring polarization of the ethereo-ponderable atoms, like that transiently produced by a galvanic discharge. (Note, page 230, vol. v, and paragraph 68.)

The magnetism transiently exhibited by a galvanized wire, is due to oppositely polarizing impulses, severally proceeding wave-like to an intermediate part of the circuit where reciprocal neutralization ensues.

When magnetism is produced by a frictional discharge operating upon a conducting wire, it must be deemed a secondary effect, arising from the polarizing influence of the ethereal waves upon the ethereo-ponderable atoms of the wire.

Such waves pass superficially in preference; but when the wire is comparatively small, the reaction between the waves and ethereo-ponderable atoms becomes sufficiently powerful to polarize them, and thus render them competent, for an extremely minute period of time, to produce all the affections of a galvano-electric current, whether of ignition, of electrolysis or magnetization. Thus, as the ethereo-ponderable waves produce such as are purely ethereal, so purely ethereal waves may produce such as are ethereo-ponderable.

The polarization of hair upon electrified scalps is supposed to be due to a superficial association with the surrounding polarized ethereal atoms, while that of iron filings, by a magnet or galvanized wire, is conceived to arise from the influence of polarized ethereo-ponderable atoms, consisting of ethereal and ponderable matter in a state of combination.

Faradian discharges are as truly the effects of ethereo-ponderable polarization, as those from an electrified conductor, or coated surfaces of glass, are due to static ethereal polarization (39, 40, 41); last paragraph, note, p. 346.

It is well known that if a rod of iron be included in a coil of coated copper wire, on making the coil the medium of a voltaic discharge, the wire is magnetized. Agreeably to a communication from Joule, in the L. and E. Phil. Mag. and Jour. for Feb., 1847, the bar is at the same time lengthened, without any augmentation of bulk; so that its other dimensions must be lessened in proportion to the elongation.

All these facts tend to prove that a change in the relative position of the constituent ethereo-ponderable atoms of iron, accompanies its magnetization, either as an immediate cause, or as a collateral effect.

ART. VI.—*Upon a peculiar kind of Isomorphism that plays an important part in the Mineral Kingdom;* by Professor SCHEERER of Christiania.*

(Continued from vol. v, p. 389.)

THE query might be started, how it is then, since aspasiolite and cordierite are so closely associated, that serpentine is not accompanied by olivine? This circumstance, which, it must be confessed, does appear paradoxical, I purpose to enter upon towards the close of this paper.

Upon the theory based on the above mentioned relations of cordierite and aspasiolite, being thus borne out by the precisely similar relations subsisting between olivine and serpentine, the probability was increased, that the part played by this species of isomorphism in the mineral kingdom was not one restrained within very narrow limits. And this opinion has taken a development more extended than I even imagined it might be susceptible of, as my investigations have been carried out. In the sequel I purpose touching upon the principal minerals concerned in this inquiry, and to develope their suitable formulæ, upon the supposition that their water may be treated as a basic constituent, capable of replacing in the ratio that has been stated, (viz. three atoms to one atom,) the magnesia, and consequently all the other bases isomorphous therewith, as for instance, protoxyd of iron, protoxyd of manganese, and so forth.

In order to express as simply as possible that in a member of a formula $\dot{R}$, a portion of the 1 : 1 atomic bases is replaced by more or less water, I have in these cases invariably made use of the sign $(\dot{R})$, as was already the case with regard to serpentine. The formula of aspasiolite would therefore, upon this principle, be $(\dot{R})^3 \ddot{S}i^2 + 3\dddot{R}\ddot{S}i$. Prior to proceeding to the results of my calculations, let me however very briefly further elucidate the kind of isomorphism forming the subject of our investigations, in a chemical point of view. From the composition of aspasiolite and of serpentine, it follows that in the former, one equivalent $\dot{R}$ (one-third of the entire 1 : 1 atomic bases contained in cordierite) is not replaced by water *exactly*. It is likewise clear that, as in serpentine the amount of water ranges between 12, 27 and 21 per cent., it does not observe any definite atomic proportion relative to the portion of the 1 : 1 atomic bases not made good by water. This is to be explained as follows, in a very simple manner, strictly upon the principle of an isomorphic substitution.

* From Poggendorff's Annalen, vol. lxviii, p. 319; translated for this Journal by Mr. W. G. LETTSOM.

From the circumstance of three equivalents of water being able to replace isomorphically one equivalent of magnesia, it directly follows that combinations such as $\dot{Mg}^3\ddot{Si}$, $\dot{Mg}^2\ddot{Si} + 3\dot{H}$, and $\dot{Mg}\ddot{Si} + 6H$, must, of necessity, possess the same crystalline form. Such combinations therefore, under this common form, can occur mixed together in every possible proportion, and thereby explain the occurrence of *non-definite proportions* in the respective amounts of water and of magnesia, not only as met with in aspasiolite and in serpentine, but also, as may be deduced from the sequel, in a very considerable number of other minerals containing water.

I. Silicates.

A. Silicates of magnesia and other bases isomorphous therewith, (minerals allied to serpentine.)

1. *Gymnite.* (Thomson.)

Oxygen ratio, $\ddot{Si} : (\dot{R}) = 20{\cdot}86 : 20{\cdot}56$. Formula deducible therefrom, $(\dot{R})^3\ddot{Si}$.

$(\dot{R})$ in this mineral = 36·00 $\dot{Mg}$, 21·60 $\dot{H}$, 0·80 $\dot{Ca}$. In addition thereto, Thomson found in gymnite 1·16 ferriferous alumina. Deducting this as a $\frac{1}{3}$ silicate, the oxygen ratio given above becomes modified to 20·36 : 20·56, approximating therefore even yet closer to 1 : 1.

2. *Deweylite.* (Shepard.)

20·78 : 21·40. $(\dot{R})^3\ddot{Si}$.

$(\dot{R})$ = 40·0 $\dot{Mg}$, 20·0 $\dot{H}$. The siliceous hydrate of alumina from Baltimore has a similar composition, according to Allan.

3. *Villarsite.* (Dufrènoy.)

20·47 : 21·37. $(\dot{R})^3\ddot{Si}$.

$(\dot{R})$ from two analyses = 45·33–47·37 $\dot{Mg}$, 4·30–3·59 $\dot{Fe}$, 2·86–2·42 $\dot{Mn}$, 0·54–0·53 $\dot{Ca}$, 0·46 $\dot{K}$, 5·80 $\dot{H}$.

4. *Dermatine.* (Ficinus.)

19·74 : 18·79. $(\dot{R})^3\ddot{Si}$.

$(\dot{R})$ in two analyses = 23·70–19·33 $\dot{Mg}$, 11·33–14·00 $\dot{Fe}$, 2·25–1·17 $\dot{Mn}$, 0·83–1·83 $\dot{Ca}$, 0·50–1·33 $\dot{Na}$, 25·20–22 $\dot{H}$, and in addition thereto, 0·42–0·83 $\ddot{Al}$; deducting this latter as $\frac{1}{3}$ silicate, the oxygen ratio becomes altered to 19·44 : 18·79.

5. *Chrysotile.* (*Metaxite*, Delesse.)

21·90 : 20·60. $(\dot{R})^3\ddot{Si}$.

$(\dot{R}) = 41{\cdot}9\,\dot{Mg}$, $3{\cdot}0\,\dot{Fe}$, $13{\cdot}6\,\dot{H}$, and in addition, $0{\cdot}4\,\ddot{Al}$. The lustrous asbestus from Reichenstein has a similar composition, according to von Kobell, as has also the Baltimorite, according to Thomson. The oxygen ratio of the former is 22·4 : 20·04, and that of the latter, 20·57 : 19·45.

6. *Chlorophæite.* (Forchhammer.)

17·07 : 17·24. $(\dot{R})^3\,\ddot{Si}$.

$(\dot{R}) = 3{\cdot}44\,\dot{Mg}$, $21{\cdot}56\,\dot{Fe}$, $42{\cdot}15\,\dot{H}$.

All these minerals, whose amount of water varies from 5·80 to 42·15 per cent., have therefore the same formula as *serpentine*, and in a chemical point of view, are only distinct therefrom in consequence of the different but isomorphous composition of the member $(\dot{R})$. Of these minerals, there is as yet but one that has been met with distinctly crystallized—this is villarsite. Its crystalline form belongs, like that of serpentine, to the rhombic system, but the prism of villarsite has angles of 120°, whereas those of serpentine are 130°. The macrodiagonals of both prisms are therefore as *tan* 65° : *tan* 60° = 2·144 : 1·732, or very nearly = 5 : 4. The form of villarsite therefore, may be supposed to be one derived from that of serpentine.

7. *Picrophyll.* (Svanberg.)

Obtained, 25·87 : 16·35 } *
Required, 25·00 : 16·66 } $(\dot{R})^3\,\ddot{Si}$.

$(\dot{R}) = 30{\cdot}10\,\dot{Mg}$, $6{\cdot}86\,\dot{Fe}$, $0{\cdot}87\,\dot{Ca}$, a trace of $\dot{Mn}$, $9{\cdot}83\,\dot{H}$, besides $1{\cdot}11\,\ddot{Al}$. Deducting this latter as a $\frac{1}{3}$ silicate, the oxygen ratio becomes = 25·52 : 16·35, very nearly therefore as 3 : 2. The analysis gave 1·52 per cent. loss.

8. *Aphrodite.* (Berlin.)

26·79 : 17·11 }
26·79 : 17·86 } $(\dot{R})^2\,\ddot{Si}$.

$(\dot{R})$ from two analyses = 33·72–34·07 $\dot{Mg}$, 1·62–1·49 $\dot{Mn}$, 0·59–0·55 $\dot{Fe}$, 12·32–11·34 $\dot{H}$, besides 0·20–0·13 $\ddot{Al}$.

9. *Spadaite.* (v. Kobell.)

29·09 : 15·38 }
29·09 : 14·55 } $(\dot{R})^3\,\ddot{Si}^2$.

$(\dot{R}) = 30{\cdot}67\,\dot{Mg}$, $0{\cdot}66\,\dot{Fe}$, $11{\cdot}34\,\dot{H}$, $0{\cdot}66\,\ddot{Al}$, 0·67 loss.

10. *Picrosmine.* (Magnus.)

28·39 : 15·16 }
30·00 : 15·00 } $(\dot{R})^3\,\ddot{Si}^2$.

* For the facility of comparison, I have with all the following minerals given the oxygen ratio *as deduced from my formula, below* the ratio obtained from the analysis.

$(\dot{R}) = 33{\cdot}35\ \dot{Mg}$, $0{\cdot}42\ \dot{Mn}$, $7{\cdot}30\ \dot{H}$ (ammoniacal), $0{\cdot}79\ \ddot{Al}$, $1{\cdot}40\ \ddot{Fe}$, 1·85 loss.

11. *Monradite.* (A. Erdmann.)

29·09 : 15·39 }
29·09 : 14·55 } $(\dot{R})^3\ \ddot{Si}^2$.

$(\dot{R}) = 31{\cdot}36\ \dot{Mg}$, $8{\cdot}56\ \dot{Fe}$, $4{\cdot}04\ \dot{H}$, 0·4 excess.

12. *Talc.* (Berthier.)

(1.) From Little St. Bernhard.

30·24 : 14·49 }
30·12 : 15·06 } $(\dot{R})^3\ \ddot{Si}^2$.

(2.) From St. Foix.

28·88 : 13·59 }
28·88 : 14·44 } $(\dot{R})^3\ \ddot{Si}^2$.

In the former, $(\dot{R}) = 33{\cdot}2\ \dot{Mg}$, $4{\cdot}6\ \dot{Fe}$, $3{\cdot}5\ \dot{H}$; in the latter, $(\dot{R}) = 19{\cdot}7\ \dot{Mg}$, $11{\cdot}7\ \dot{Fe}$, $8{\cdot}1\ \dot{Ca}$, $2{\cdot}6\ \dot{H}$. The talc from St. Foix contains moreover $1{\cdot}7\ \ddot{Al}$. Deducting this as a $\frac{2}{3}$ silicate, we obtain the oxygen ratio = 27·69 : 13·59, also very nearly = 2 : 1.

13. *Meerschaum.*

(1.) From Cabanas, according to Berthier, 27·95 : 15·14.
(2.) From Coulommiers, according to the same, 28·05 : 15·22.
(3.) From Morocco, according to Damour, 28·57 : 14·28.

} $(\dot{R})^3\ \ddot{Si}^2$.

All the three oxygen ratios are more or less nearly = 2 : 1. Lychnell however has analyzed a meerschaum from the Levant, whose oxygen ratio is 31·62 : 14·11. Supposing this mineral not to have been too highly dried, and to have been in a state of purity, the formula $\dot{Mg}\,\ddot{Si} + \dot{H}$ must be adopted for it. *Spadaite*, *picrosmine*, *monradite*, *talc*, and perhaps also *meerschaum*, have, as is seen above, one and the same chemical formula. The amount of water in the member (R) ranges between the limits 2·6 (talc) and 20 (meerschaum). Picrosmine, monradite and talc occur crystallized, and all three of them *in crystals belonging to the rhombic system*. In picrosmine the obtuse angles of the rhombic prism are very nearly 127°, in monradite 130°, and in talc 120°. The rhombic prism of monradite and of picrosmine agrees also very nearly with the prism of serpentine, whereas that of talc is the same as that of villarsite. This accordance may cause some surprise, inasmuch as the formula for serpentine and villarsite is $(\dot{R})^3\ \ddot{Si}$, whereas for the other three minerals the formula is $(\dot{R})^3\ \ddot{Si}^2$. From analogous instances however, we are

aware that minerals which we may look upon as different grades of saturation of one and the same radical, (be it simple or compound,) affect, *in numerous instances*, the same, or at any rate a very similar crystalline form.*

14. *Retinalite.* (Thomson.)

$$\left.\begin{array}{l} 21{\cdot}07\,\ddot{\mathrm{Si}} : 13{\cdot}22\,(\dot{\mathrm{R}}) : 4{\cdot}82\,\dot{\mathrm{Na}} \\ 20{\cdot}25 \quad : 13{\cdot}50 \quad\;\; : 4{\cdot}50 \end{array}\right\} \quad 2(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}+\dot{\mathrm{Na}}^2\,\ddot{\mathrm{Si}}.$$

$(\dot{\mathrm{R}}) = 18{\cdot}86\,\dot{\mathrm{Mg}}$, $20{\cdot}0\,\dot{\mathbf{H}}$, $0{\cdot}62\,\ddot{\mathbf{F}}\mathrm{e}$, $0{\cdot}30\,\ddot{\mathbf{A}}\mathrm{l}$, $0{\cdot}84$ loss.

15. *Some "Serpentine-like Minerals."* (Schweitzer.)†

(1.) From Monte Rosa, 22·65 : 20·50.
(2.) From Zermatt, 22·68 : 20·39.
(3.) From Col de Breona, 22·97 : 19·30.

Mean of the three analyses:

$$\left.\begin{array}{l} 22{\cdot}77 : 20{\cdot}06 \\ 22{\cdot}77 : 20{\cdot}24 \end{array}\right\} \quad 2(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}+(\dot{\mathrm{R}})^2\,\ddot{\mathrm{Si}}.$$

In the first member of this formula, $(\dot{\mathrm{R}})$ consists of magnesia, water and protoxyd of iron, whereas in the second it consists chiefly only of magnesia. The formula may therefore, and indeed with greater propriety, be thus expressed: $2(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}+\dot{\mathrm{Mg}}^2\,\ddot{\mathrm{Si}}$. In which case it is quite analogous to that of retinalite.

16. *Schillerspar.* (Köhler.)

$$\left.\begin{array}{l} 22{\cdot}59 : 17{\cdot}12 \\ 22{\cdot}83 : 17{\cdot}12 \end{array}\right\} \quad 2(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}+(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}^2.$$

The 1 : 1 atomic bases are according to two analyses = 25·86 –26·16 $\dot{\mathrm{Mg}}$, 2·64 to 2·75 $\dot{\mathrm{Ca}}$, 10·92 $\dot{\mathrm{Fe}}$, 0·54 to 0·57 $\dot{\mathrm{Mn}}$, 12·43 $\dot{\mathbf{H}}$. It appears more natural to assume that in the first member of this formula, $2(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}$, we should have *a portion* of the magnesia, and in addition thereto, *the whole* of the protoxyd of iron and the water as $\frac{1}{3}$ silicates; and in the second member of the formula, $(\dot{\mathrm{R}})^3\,\ddot{\mathrm{Si}}^2$, the remainder of the magnesia and the whole of the

* One instance that occurs to me, is in Smaltine and Skutterudite. Although the formula of the former is $\mathrm{Co\,As^2}$, and that of the latter $\mathrm{Co\,As^3}$, yet their crystalline form is precisely alike. Another example is offered by the feldspars, whose atomic composition may be thus expressed.

$\dot{\mathrm{R}}\;\ddot{\mathbf{A}}\mathrm{l}\;\ddot{\mathrm{Si}}$
3 : 3 : 4 = Anorthite.
3 : 3 : 6 = Labrador, Ryacolite.
3 : 3 : 8 = Andesine.
3 : 3 : 9 = Oligoclase.
3 : 3 : 12 = Orthoclase, Albite.

In accordance herewith, the feldspars are different grades of saturation of a radical compounded of equal atoms of $\dot{\mathrm{R}}$ and $\ddot{\mathbf{A}}\mathrm{l}$.

† See Erdmann and Marchand's J. f. P. Ch., vol. xxxii, p. 499; and Pogg. Ann., vol. xlviii.

lime as ⅔ silicates. This would give us the formula thus modified, $2(\dot{R})^3\ddot{S}i+(\dot{R})^3\ddot{S}i^2$. *Schillerspar may therefore be looked upon as consisting of two atoms of serpentine and one atom of augite.* And this is in accordance with the known fact, that the occurrence of schillerspar appears to be closely limited to formations in which serpentine is met with. In the above oxygen ratio, the presence of 2·37 $\ddot{C}r$, and of 1·28 to 1·73 $\ddot{A}l$, is not taken into account. What part these substances probably play in the composition of the mineral in question, will be broached as a conjecture in the sequel.

17. *Crocidolite.* (Stromeyer.)

26·61 : 11·99 }
26·61 : 11·40 } $3(\dot{R})\ddot{S}i+2(\dot{R})^3\ddot{S}i^2$.

$(\dot{R})$ from two analyses =34·38 $\dot{F}e$, 2·48 $\dot{M}g$, 0·09 $\dot{M}n$, 0·03 $\dot{C}a$, 7·07 $\dot{N}a$, 4·80 $\dot{H}$. The constituents are present in such proportions as would also admit of the formula, $3(\dot{R})\ddot{S}i+2\dot{F}e^3\ddot{S}i^2$.

$(\dot{R})$ in this case comprehending the whole soda, water, and magnesia. Compare this formula with that of hornblende, $\dot{R}\ddot{S}i+\dot{R}^3\ddot{S}i^2$.

Retinalite, Schweitzer's "*serpentine-like minerals*" (to which forsooth, a general distinctive name should be given) and *schiller spar*, form therefore a peculiar group of minerals the formula of which consists of two other members, one of them being serpentine, and therefore containing water, while the other member consists of an anhydrous silicate, but which also contains, as in the former member, 1 : 1 atomic bases. Crocidolite approaches a hydrous hornblende.

B. Silicates of magnesia and of other bases isomorphous therewith in combination with aluminates and oxydates of iron.

Chlorite and the minerals allied thereto.

1. *Chlorite.*

16·30 $\ddot{S}i$: 7·85 $\ddot{A}l$: 17·72 $(\dot{R})$ }
15·42 : 7·71 : 18·00 } $2(\dot{R})^3\ddot{S}i+(\dot{R})\ddot{A}l$.

The oxygen ratio here given, is calculated from the mean of five analyses, namely, two analyses by v. Kobell of the chlorite of Achmatoffsk, his analysis of the Schwarzenstein chlorite, Varrentrapp's analysis of the Achmatoffsk cholite, and v. Brüels of that from the Zillerthal.

2. *Chlorite-slate.* (Varrentrapp.)

16·39 : 5·66 : 18·84 }
16·39 : 5·46 : 18·21 } $3(\dot{R})^3\ddot{S}i+(\dot{R})\ddot{A}l$.

This chlorite slate was from the Pfitschthal. The composition of chlorite bears therefore a very simple relation to that of chlorite slate.

3. *Ripidolite.*

1.) From Rauris, according to v. Kobell:
13·54 : 8·63 : 16·04.

(2.) From St. Gothardt, according to Varrentrapp:
13·18 : 8·64 : 15·81.

(3.) From the Zillerthal, according to v. Kobell:
14·19 : 9·70 : 16·76.

Mean of the three analyses:

13·67 : 8·99 : 16·20 }
13·50 : 9·00 : 16·50 } $3(\dot{R})^3\,\ddot{S}i+2(\dot{R})\,\ddot{A}l.$

4. *Pennine.* (Schweitzer.)

17·38 : 4·44 : 18·80 }
17·38 : 4·35 : 18·83 } $4(\dot{R})^3\,\ddot{S}i+(\dot{R})\,\ddot{A}l.$

The oxygen ratio is calculated from the mean of two experiments.

5. *Xanthophyllite.* (Meitzendorff.)

8·47 : 20·53 : 13·20 }
8·80 : 19·80 : 13·20 } $4(\dot{R})^3\,\ddot{S}i+3(\dot{R})^2\,\ddot{A}l^2.$

From the mean of four analyses.

6. *Leuchtenbergite.* (Komonen.)

17·78 : 8·38 : 16·74 }
17·00 : 8·50 : 15·60 } $4(\dot{R})^2\,\ddot{S}i+(\dot{R})^3\,\ddot{A}l^2.$

It is here assumed, in accordance indeed with Komonen, that this mineral contains no protoxyd of iron, but 3·33 per cent. of the peroxyd. Leuchtenbergite is of a pale yellow, almost, indeed, colorless, and can therefore scarcely be supposed to contain enough of the protoxyd to correspond with 3·33 $\ddot{F}e$. It is possible that the oxygen ratio may be 17·0 : 8·5 : 17, and this would agree more closely with the ratio obtained from analysis than what is given above. But in that case the formula would be, $2(\dot{R})^2\,\ddot{S}i+(\dot{R})^2\,\ddot{A}l$, which does not, it is true, appear probable, inasmuch as the silica and the alumina are therein combined with equal quantities of base. It may be further supposed that the base in combination with the silica consists only of magnesia (with a certain quantity of lime), while that combined with the alumina is composed of magnesia and water. The mineral, it is to be observed, contains 35·36 Mg, 1·75 Ca, 8·68 $\dot{H}$. The formula would then become modified as follows,

$$2\,\dot{M}g^2\,\ddot{S}i+(\dot{R})^2\,\ddot{A}l.$$

Cases analogous thereto have been already adduced, and there is another similar instance in the composition of the next mineral.

7. *Chlorite mineral*, from Taberg. (Svanberg.)*

18·58 : 6·09 : 16·98 }
18·50 : 6·16 : 16·44 } $3(\dot{R})^3\,\ddot{S}i+(\dot{R})^3\,\ddot{A}l$,

which formula may likewise be thus given, $3\dot{M}g^3\,\ddot{S}i+(\dot{R})^3\,\ddot{A}l$.

The mineral contains 29·27 Mg, 2·07 K, 6·34 Fe, 1·64 Mn, 11·76 **H**, and these bases are present in such proportions as will admit of the entire magnesia and potash being combined with the silica, while the whole of the other *weaker* bases may be supposed to be in combination with the alumina. Hitherto, this mineral, notwithstanding its great external resemblance to chlorite, was reckoned among the micas, because the quantity of the 1 : 1 atomic bases which it contains (not counting the water therewith), is not sufficient for a member of the chlorite family; now however, by including the water among the basic constituents, the mineral in fact takes its place among the chlorite group.

8. *Kämmererite.* (Hartwall.)

19·20 : 6·90 : 16·83 }
19·50 : 6·50 : 16·25 } $6(\dot{R})_2\,\ddot{S}i+(\dot{R})^3\,\ddot{A}l$.

Pyrosclerite (v. Kobell) appears to have the same formula, unless indeed the loss of 1·9 per cent. in the analysis should cause an alteration therein.

9. *Chloritoid.* (v. Bonsdorf.)

14·28 : 16·61 : 9·95 }
15·00 : 15·00 : 10·00 } $(\dot{R})^3\,\ddot{S}i^2+(\dot{R})\,\ddot{A}l^2$.

The analysis gave an excess of 1·64. $(\dot{R})$=27·05 Fe, 4·29 Mg, 0·30 Mn, 6·95 **H**. A. Erdmann has examined another chloritoid which contains no water, and which (as the mean of two analyses) gives the following oxygen ratio.

12·95 : 21·02 : 6·82 }
13·00 : 19·50 : 6·50 } $2(\dot{R})\ddot{S}i+\dot{R}\,\ddot{A}l^3$,

this therefore, as has been remarked by Rammelsberg, is evidently another mineral.

10. *Soapstone.* (Svanberg.)

24·32 : 3·87 : 16·39 }
23·40 : 3·90 : 16·90 } $6(\dot{R})^2\,\ddot{S}i+(\dot{R})\,\ddot{R}$.

$(\dot{R})$=33·3 Mg, 0·7 Ca, 11·0 **H**; $\ddot{R}$=8·0 $\ddot{A}l$, 0·4 $\ddot{F}e$.

11. *Cronstedite.*

The formula of this mineral, according to v. Kobell, is

$\left.\begin{matrix}\dot{F}e^3\\ \dot{M}n^3\\ \dot{M}g^3\end{matrix}\right\}\ \ddot{S}i+\ddot{F}e\,\dot{H}^3$,

* See Berzelius's Jahresbericht, Jahrg. 20, Part 2, p. 234.

which admits of being thus written $(\dot{R})^3\,\ddot{S}i+(\dot{R})\ddot{F}e$. This formula differs from that of chlorite from the member $(\dot{R})\,\ddot{S}i$ being contained therein but singly, whereas in chlorite it is doubled, and that it contains peroxyd of iron instead of alumina. That cronstedtite finds a place among the minerals of the chlorite family by the new formula here proposed for it, is without doubt amply borne out by its external characters. Its crystalline form is a hexagonal prism, with a cleavage parallel to the terminal plane.

Chlorite, ripidolite, pennine and the other chlorite minerals treated of here, all receive, as is seen above, formulæ consisting of two members, and which, generally speaking, are very simple. One of these members consists of a silicate, the other of an aluminate or an oxydate of iron.

C. silicates of magnesia and alumina, and bases isomorphous therewith.

(*a.*) *Mica and micaceous minerals.*

1. *Mica from Iviken.* (Svanberg.)

36·97 : 7·74 : 2·78 }
36·97 : 7·40 : 2·47 } $(\dot{R})\,\ddot{S}i^2+\ddot{R}\,\ddot{S}i^3$.

2. *Mica from Brattstad.* (The same.)

33·08 : 12·66 : 1·93 }
32·00 : 12·80 : 2·13 } $(\dot{R})\,\ddot{S}i+2\ddot{R}\,\ddot{S}i^3$.

The analysis gave an excess of 0·89.

3. *Mica from Broddbo.* (The same.)

24·92 : 16·95 : 2·39 }
25·00 : 16·66 : 2·77 } $(\dot{R})\,\ddot{S}i+2\ddot{R}\,\ddot{S}i$.

Very closely agreeing with the mica from Utön, Kimito, Fahlun and Ochotsk, according to the analyses of Henry Rose. If a small quantity of manganese which is given in Svanberg's analysis as oxyd is calculated as protoxyd, the formula agrees even closer, inasmuch as in that case the oxygen ratio is then = 24·92 : 16·61 : 2·73.

4. *Mica from Rosendal.* (The same.)

23·07 : 7·87 : 10·45 }
23·61 : 7·87 : 10·49 } $2(\dot{R})^2\,\ddot{S}i+\ddot{A}l\,\ddot{S}i$.

5. *Mica from Pargas.* (The same.)

22·13 : 13·31 : 6·64 }
23·00 : 13·20 : 6·60 } $3(\dot{R})^2\,\ddot{S}i+4\ddot{R}\,\ddot{S}i$.

The analysis gave 1·19 *loss.*

6. *Mica from Monroe.* (v. Kobell.)

20·78 : 9·85 : 11·06 }
21·00 : 10·50 : 10·50 } $(\dot{R})^3\,\ddot{S}i+\ddot{R}\,\ddot{S}i$.

The same formula appears to apply to the mica from Miask and from Karosulik. According to v. Kobell's analysis, their respective oxygen ratio is; 21·88 : 9·18 : 10·15 and 21·30 : 9·26 : 11·14. The formula adduced, which is that of garnet, has been before applied to these micas, but from not including the water among the basic constituents, the analyses indicated a want of 1 : 1 atomic bases.

7. *Mica from Abborforss.* (Svanberg.)

20·49 : 15·30 : 3·67
20·00 : 16·00 : 4·00 $\}$ $(\dot{R})^3 \ddot{S}i + \ddot{\mathbf{R}} \ddot{S}i.$

8. *Mica from Sala.* (The same.)

22·06 : 6·01 : 13·65
21·00 : 7·00 : 14·00 $\}$ $2(\dot{R})^3 \ddot{S}i + \ddot{\mathbf{R}} \ddot{S}i.$

9. *Pyrophyllite.* (Herrmann.)

31·06 : 13·76 : 3·54
31·00 : 13·78 : 3·44 $\}$ $3(\dot{R})\ddot{S}i + 2\ddot{\mathbf{A}}l^2 \ddot{S}i^3.$

The insignificant amount of iron in this mineral has been calculated as protoxyd (=1·16 per cent.), although it is cited as peroxyd. It may be remarked, that the color of the mineral is *green*, and the analysis indicated a slight excess.

10. *Pinite from Auvergne.* (C. Gmelin.)

29·07 : 13·50 : 3·00
29·00 : 12·88 : 3·22 $\}$ $3(\dot{R})\ddot{S}i + 2\ddot{\mathbf{R}}^2 \ddot{S}i^3.$

This pinite has therefore the same formula as Herrmann's pyrophyllite, the preceding mineral. The difference between them consists but in this, 1st, that in pyrophyllite there is only alumina, whereas pinite contains peroxyd of iron as well, and 2d, that in the former $(\dot{R})$=4Mg, 1·6 Fe, 5·62 $\dot{\mathbf{H}}$, in the latter =3·76 Mg and Mn, 7·89 K, 0·39 Na, 1·41 $\dot{\mathbf{H}}$. Both minerals appear to crystallize in the rhombic system. But it does not seem probable to me that they should affect *precisely* similar forms, inasmuch as the amount of potash contained in pinite is too considerable for that.

11. *Pinite from Penig.* (Scott.)

21·94 : 16·04 : 3·02
25·00 : 16·67 : 2·78 $\}$ $(\dot{R})\ddot{S}i + 2\ddot{\mathbf{A}}l \ddot{S}i.$

This is the formula of the Broddbo mica. In the latter, $(\dot{R})$=8·31 K, 1·5 Mn, 3·32 $\dot{\mathbf{H}}$; in pinite =11·35 K, 0·75 Ca and 3·00 $\dot{\mathbf{H}}$. Assuming about a third of the iron in the mineral to exist in the state of the protoxyd, for which supposition, however, (excepting, perhaps, that the analysis indicates an excess of 0·76 per cent.) there is no particular ground, the oxygen ratio becomes,

$$\left.\begin{matrix}24{\cdot}94 : 15{\cdot}12 : 3{\cdot}63 \\ 24{\cdot}00 : 16{\cdot}00 : 4{\cdot}00\end{matrix}\right\} \quad (\dot{R})^3\,\ddot{S}i^2 + 4\ddot{R}\,\ddot{S}i,$$

which would give this pinite the same formula as the following mineral. The formula first stated represents it, however, evidently better.

12. *Gigantolite.* (Trolle Wachtmeister.)

$$\left.\begin{matrix}24{\cdot}04 : 16{\cdot}51 : 4{\cdot}21 \\ 24{\cdot}00 : 16{\cdot}00 : 4{\cdot}00\end{matrix}\right\} \quad (\dot{R})^3\,\ddot{S}i^2 + 4\ddot{R}\,\ddot{S}i.$$

The analysis gave an *excess* of 1·56.

13. *Chlorophyllite.* (Jackson.)

$$\left.\begin{matrix}23{\cdot}48 : 12{\cdot}98 : 7{\cdot}75 \\ 24{\cdot}00 : 12{\cdot}00 : 8\,00\end{matrix}\right\} \quad (\dot{R})^2\,\ddot{S}i + \ddot{A}l\,\ddot{S}i.$$

A small amount of potash (1·64 per cent.) was estimated only from the loss.

14. *Ottrelite.* (Damour.)

$$\left.\begin{matrix}22{\cdot}51 : 11{\cdot}50 : 7{\cdot}31 \\ 22{\cdot}50 : 11{\cdot}25 : 7{\cdot}50\end{matrix}\right\} \quad (\dot{R})^2\,\ddot{S}i + \ddot{A}l\,\ddot{S}i.$$

This and the foregoing mineral have the same formula. In point of fact, both minerals occur in the same crystalline form, that of a hexagonal prism. $(\dot{R})$ in Ottrelite = 16·72 $\dot{F}e$, 8·18 $\dot{M}n$, 5·66 $\dot{H}$. In chlorophyllite $(\dot{R})$ = 9·6 $\dot{M}g$, 8·26 $\dot{F}e$, 4·1 $\dot{M}n$, 1·64 $\dot{K}$, 3·6 $\dot{H}$.

Although the amount of water in the above named *varieties of mica* and *micaceous minerals*, generally speaking, is but moderate, ranging, as it does, between about one and six per cent., yet it, in most instances, exercises a considerable influence upon the formula of these minerals. For the greater part of them contain such a limited portion of the 1 : 1 atomic bases, that their quantity of oxygen is materially increased by that of the water, even when the amount of the latter does not exceed two per cent. If we neglect this amount of water, or endeavor to treat it as hydrate-water, we arrive for the most part at improbable and complicated formulæ, neither indicative of symmetrical relations between themselves, nor when compared with the formulæ of other minerals; objections to which the formula here adduced, as far at least as the majority of them is concerned, are assuredly not liable. Many varieties of mica contain minute quantities, scarcely exceeding one per cent., of compounds of fluorine, especially fluorid of calcium and fluorid of magnesium, which were not here taken into account. It is probable they replace a portion of the corresponding 1 : 1 atomic bases.

(*b.*) *Non-micaceous minerals.*—(*a.*) *Crystalline.*

1. *Fahlunite.* (Trolle Wachtmeister.)

22·89 : 14·09 : 7·30 }
22·90 : 14·60 : 7·30 } $(\dot{R})^3\,\ddot{S}i+2\,\ddot{\mathbf{R}}\,\ddot{S}i.$

From the mean of two analyses.

2. *Esmarkite.* (A. Erdmann.)

23·88 : 14·98 : 7·40 }
23·00 : 15·33 : 7·66 } $(\dot{R})^3\,\ddot{S}i+2\,\ddot{\mathbf{A}}l\,\ddot{S}i.$

The analysis gave a *loss* of 1·45. According to the above, fahlunite and esmarkite have the formula of epidote, as has likewise Meionite. In esmarkite $(\dot{R})$ = 8·99 Mg, 4·10 Na, 1·43 Fe, 0·63 Mn, 0·68 K, 3.20 **H**, in fahlunite 6·04 to 6·75 Mg, 0·0 to 7·22 Fe, 1·72 to 2·24 Mn, 0·0 to 4·45 Na, 0·94 to 1·98 K, trace to 1·35 Ca, 8·65 to 11·66 **H**.

3. *Pyrargillite.* (Nordenskjöld.)

22·82 : 13·51 : 7·56 }
22·00 : 14·66 : 7·33 } $(\dot{R})^3\,\ddot{S}i+2\,\ddot{\mathbf{A}}l\,\ddot{S}i,$

formula of the two foregoing minerals, and likewise of the others cited above. $(\dot{R})$ = 5·30 Fe, 2·90 Mg and Mn, 1·05 K, 1·85 Na, 15·47 **H**. Pyrargillite, as also fahlunite, appears to affect a rhombic crystalline form. That of esmarkite is not known.

4. *Praseolite.* (A. Erdmann.)

21·27 : 13·47 : 9·16 }
22·00 : 13·20 : 8·80 } $2\,(\dot{R})^3\,\ddot{S}i+3\,\ddot{\mathbf{A}}l\,\ddot{S}i.$

5. *Zeuxite.* (Thomson.)

17·37 : 14·87 : 8·16 }
17·50 : 15·00 : 7·50 } $3\,(\dot{R})^3\,\ddot{S}i+2\,\ddot{\mathbf{A}}l^3\,\ddot{S}i^2.$

6. *Roselane.* (Svanberg.)

23·33 : 16·37 : 4·86 }
23·33 : 15·55 : 5·18 } $(\dot{R})^3\,\ddot{S}i+2\,\ddot{\mathbf{A}}l\,\ddot{S}i.$

$(\dot{R})$ = 6·63 K, 3·59 Ca, 2·45 Mg, 6·53 **H**. The oxygen ratio of polyargite (Svanberg) resembles that of roselane very closely, viz., 22·93 : 16·69 : 4·80.

$(\dot{R})$ = 6·73 K, 5·55 Ca, 1·43 Mg a trace, Mn, 5·29 **H**. Both minerals, moreover, have a similar cleavage, similar specific gravity and a similar color.

7. *Kirwanite.* (Thomson.)

21·04 : 5·32 : 12·28 }
21·00 : 6·00 : 12·00 } $6\,(\dot{R})^3\,\ddot{S}i+\ddot{\mathbf{A}}l\,\ddot{S}i.$

8. *Stellite.* (The same.)

24·98 : 3·70 : 12·67 }
25·00 : 4·17 : 12·50 } $9(\dot{R})^3\,\ddot{S}i+\ddot{R}^3\,\ddot{S}i^3$.

It is here assumed that this mineral contains, not as Thomson asserts, 3·524 protoxyd of iron, but a corresponding quantity of peroxyd. The mineral, it must be remarked, is *snow-white*, and the alumina which amounts only to 5·301 would not, of itself, be sufficient. The formula of stellite would also answer for Thomson's vermiculite, whose oxygen ratio = 25·50 : 3·40 : 13·26, if indeed, as Thomson says, the whole of the iron is contained in the form of a protoxyd. Calculating a small portion thereof to exist in the state of peroxyd would afford an oxygen ratio still closer to that of stellite. The two minerals, however, in spite of similar formula, applicable perhaps to both, are essentially different from each other. For, whereas, in stellite $(\dot{R}) = 30{\cdot}96\,\dot{C}a$, $5{\cdot}58\,\dot{M}g$, $6{\cdot}108\,\dot{H}$, in vermiculite $(\dot{R}) = 16{\cdot}12\,\dot{F}e$, (or upon the aforesaid supposition somewhat less,) $16{\cdot}964\,\dot{M}g$, $10{\cdot}276\,\dot{H}$.

9. *Weissite.* (Trolle Wachtmeister.)

31·01 : 10·17 : 5·76 }
31·00 : 10·33 : 5·17 } $(\dot{R})^3\,\ddot{S}i^2+2\,\ddot{A}l\,\ddot{S}i$.

Remark.—This is where *aspasiolite* belongs, whose formula, as has been already stated, is $(\dot{R})^3\,\ddot{S}i^3+3\,\ddot{R}\,\ddot{S}i$.

10. *Rhodalite.* (Thomson.)

29·04 : 7·38 : 7·07 }
29·00 : 7·25 : 7·25 } $3(\dot{R})\,\ddot{S}i+\ddot{R}\,\ddot{S}i$.

$(\dot{R})$ consists *almost entirely of water*, inasmuch as it is $= 1{\cdot}1\,\dot{C}a$, $0{\cdot}6\,\dot{M}g$ and $22{\cdot}0\,\dot{H}$. According to Thomson, this mineral occurs in aggregated rectangular prisms.

11. *Neurolite.* (The same.)

37·92 : 8·23 : 2·77 }
38·00 : 7·60 : 2·53 } $(\dot{R})\,\ddot{S}i^2+\ddot{A}l\,\ddot{S}i^2$,

formula of the Iviken mica. In that, $(\dot{R}) = 4{\cdot}661\,\dot{M}g$, $3{\cdot}528\,\dot{K}$, $1{\cdot}292\,\dot{H}$, and $1{\cdot}197\,\dot{C}a$. In neurolite, $(\dot{R}) = 3{\cdot}25\,\dot{C}a$, $1{\cdot}50\,\dot{M}g$, $4{\cdot}30\,\dot{H}$.

β. Amorphous.*

1. *Pitchstone.* (Du Menil.)

37·92 : 5·65 : 3·08 }
38·00 : 5·43 : 3·62 } $2(\dot{R})\,\ddot{S}i^2+\ddot{R}\,\ddot{S}i^3$.

* Or at least apparently so. Some of these minerals consist perhaps of an aggregation of microscopic crystals.

The analysis showed however a *loss* of 2·24. The pitchstone was from the Triebischthale near Meissen. The same mineral was examined also by Erdmann; the oxygen ratio obtained by him was = 39·27 : 5·79 : 4·55, but this analysis gave an *excess* of 3·948. The stone appears indeed worthy of its name!* Knox moreover examined a pitchstone from Newry, whose oxygen ratio was 37·82 : 5·37 : 4·26, and the analysis of which indicated a very trifling loss only—not above 0·2 per cent. The above formula therefore cannot well be very far from the truth.

2. *Cimolite.* (Klaproth.)

$$\left.\begin{matrix}32{\cdot}73 : 11{\cdot}12 : 3{\cdot}56 \\ 33{\cdot}00 : 11{\cdot}00 : 3{\cdot}66\end{matrix}\right\} \quad (\dot{R})\,\ddot{S}i + \ddot{A}l\,\ddot{S}i^{3}.$$

This is the formula of soda-spodumene. In cimolite however, $(\dot{R})$ consists only of *water*.

3. *Onkosine.* (v. Kobell.)

$$\left.\begin{matrix}27{\cdot}28 : 14{\cdot}42 : 4{\cdot}26 \\ 28{\cdot}00 : 14{\cdot}00 : 4{\cdot}66\end{matrix}\right\} \quad (\dot{R})\,\ddot{S}i + \ddot{A}l\,\ddot{S}i,$$

the formula of labradorite and ryacolite. $(\dot{R}) = 6{\cdot}38\,\dot{K}, 3{\cdot}82\,\dot{M}g, 0{\cdot}80\,\dot{F}e, 4{\cdot}60\,\dot{H}$. The analysis showed a loss of 1 per cent.

4. *Pipestone.* (*Catlinite*, Jackson.)

$$\left.\begin{matrix}29{\cdot}15 : 10{\cdot}22 : 5{\cdot}23 \\ 30{\cdot}00 : 10{\cdot}00 : 5{\cdot}00\end{matrix}\right\} \quad 3(\dot{R})\,\ddot{S}i + \ddot{R}^{3}\,\ddot{S}i^{3}.$$

$(\dot{R}) = 12{\cdot}48\,\dot{H}, 2{\cdot}16\,\dot{C}a, 0{\cdot}20\,\dot{M}g$, and $4{\cdot}58\,\dot{H}$.

5. *Fettbol.* (Kersten.)

$$\left.\begin{matrix}24{\cdot}11 : 8{\cdot}61 : 7{\cdot}26 \\ 24{\cdot}00 : 8{\cdot}00 : 8{\cdot}00\end{matrix}\right\} \quad (\dot{R})^{3}\,\ddot{S}i^{2} + \ddot{R}\,\ddot{S}i.$$

The analysis gave a *loss* of 2·59. $(\dot{R}) = 24{\cdot}50\,\dot{H}$. The formula is that of tachylite.

6. *Huronite.* (Thomson.)

$$\left.\begin{matrix}23{\cdot}79 : 15{\cdot}84 : 5{\cdot}12 \\ 25{\cdot}00 : 15{\cdot}00 : 5{\cdot}00\end{matrix}\right\} \quad (\dot{R})^{3}\,\ddot{S}i^{2} + 3\ddot{A}l\,\ddot{S}i.$$

$(\dot{R}) = 8{\cdot}04\,\dot{C}a, 4{\cdot}32\,\dot{F}e, 1{\cdot}72\,\dot{M}g, 4{\cdot}16\,\dot{H}$. *Loss*, 2·04.

7. *Agalmatolite.* (Thomson.)

$$\left.\begin{matrix}25{\cdot}88 : 14{\cdot}29 : 4{\cdot}47 \\ 25{\cdot}00 : 15{\cdot}00 : 5{\cdot}00\end{matrix}\right\} \quad (\dot{R})^{3}\,\ddot{S}i^{2} + 3\ddot{R}\,\ddot{S}i.$$

* There is an untranslatable play upon the word "*pech*" here. I regret being unable to render it into English, as a joke in German, from its extreme rarity, always possesses a certain value.—*Translator.*

$(\dot{R}) = 6{\cdot}00\,\dot{Ca}$, $6{\cdot}8\,\dot{K}$, $5{\cdot}5\,\mathbf{\dot{H}}$. Huronite and agalmatolite appear to have the same formula therefore, namely, that of aspasiolite. But in the latter, $(\dot{R}) = 6{\cdot}97$ to $8{\cdot}04\,\dot{Mg}$, $\dot{Ca}$, a trace, $2{\cdot}30$ to $2{\cdot}39\,\dot{Fe}$ (a part thereof perhaps as $\ddot{\mathbf{Fe}}$), $\dot{Mn}$ a trace, $6{\cdot}58$ to $6{\cdot}88\,\mathbf{\dot{H}}$.

8. ———, from Plombières. (Berthier.)

$$\left.\begin{matrix}22{\cdot}86 : 10{\cdot}28 : 8{\cdot}18\\ 23{\cdot}00 : 11{\cdot}50 : 7{\cdot}67\end{matrix}\right\} \quad (\dot{R})^3\,\ddot{Si} + \ddot{\mathbf{Al}}\,\ddot{Si}.$$

$1{\cdot}0$ *loss.* $(\dot{R}) = 25{\cdot}0\,\mathbf{\dot{H}}$, $2{\cdot}0\,\dot{Mg}$. The bole from Stolpen, which has been analyzed by Rammelsberg, appears to have the same formula. Its oxygen ratio is $= 23{\cdot}86 : 10{\cdot}35 : 8{\cdot}76$, whereby it is to be noticed that a loss of $2{\cdot}17$ per cent. was obtained. $(\dot{R})$ in this bole $= 25{\cdot}86\,\mathbf{\dot{H}}$, $3{\cdot}90\,\dot{Ca}$.

9. *Nontronite*, from Villefranche. (Dufrénoy.)

$$\left.\begin{matrix}21{\cdot}13 : 11{\cdot}12 : 7{\cdot}73\\ 22{\cdot}00 : 11{\cdot}00 : 7{\cdot}33\end{matrix}\right\} \quad (\dot{R})^2\,\ddot{Si} + \ddot{\mathbf{R}}\,\ddot{Si}.$$

Essentially this is the formula of the preceding mineral. $(\dot{R}) = 23{\cdot}0\,\mathbf{\dot{H}}$, $2{\cdot}37\,\dot{Mg}$. Chlorophyllite also (which see), and ottrelite (see likewise), have this formula.

10. *Kaolin.* (Forchhammer.)

Its formula, $\ddot{\mathbf{Al}}^3\,\ddot{Si}^4 + 6\mathbf{\dot{H}}$, may be also thus expressed:

$$(\dot{R})^2\,\ddot{Si} + 3\ddot{\mathbf{Al}}\,\ddot{Si}.$$

11. *Nontronite*, from Andreasberg. (Biewend.)

$$\left.\begin{matrix}21{\cdot}35 : 11{\cdot}44 : 6{\cdot}39\\ 21{\cdot}00 : 12{\cdot}00 : 6{\cdot}00\end{matrix}\right\} \quad 3(\dot{R})^2\,\ddot{Si} + 4\ddot{\mathbf{Fe}}\,\ddot{Si},$$

formula of the Pargas mica, in which however, $(\dot{R}) = 10{\cdot}27\,\dot{Mg}$, $0{\cdot}75\,\dot{Mn}$, $0{\cdot}26\,\dot{Ca}$, $8{\cdot}45\,\dot{K}$, $3{\cdot}35\,\mathbf{\dot{H}}$, whereas $(\dot{R})$ in nontronite consists of water alone, (21·56 per cent.) The nontronite of Autun shows, according to Berthier's analysis, a similar oxygen ratio to that from Andreasberg, that is to say, $21{\cdot}46 : 10{\cdot}94 : 5{\cdot}58$. This would perhaps bear out the formula, $(\dot{R})^3\,\ddot{Si}^2 + 2\ddot{\mathbf{R}}\,\ddot{Si}$, which is at the same time that of scapolite and of amphodelite, and which requires an oxygen ratio of $21{\cdot}5 : 10{\cdot}75 : 5{\cdot}38$.

12. *Saponite.* (*Piotine*, Svanberg.)

$$\left.\begin{matrix}26{\cdot}45 : 5{\cdot}02 : 13{\cdot}76\\ 26{\cdot}00 : 5{\cdot}20 : 13{\cdot}86\end{matrix}\right\} \quad 4(\dot{R})^2\,\ddot{Si} + \ddot{\mathbf{Al}}\,\ddot{Si}.$$

13. *Pinguite.* (Kersten.)

Its formula, $\dot{Fe}\,\ddot{Si}+\ddot{\mathbf{Fe}}^2\,\ddot{Si}^3+15\dot{\mathbf{H}}$, may be also thus written, $(\dot{R})^3\,\ddot{Si}+\ddot{\mathbf{Fe}}\,\ddot{Si}$, which is the formula of garnet and likewise of the mica from Miask, Monroe and Karosulik.

14.

According to Löwigs and Wackenroder's analyses of the boles from Ellinghausen, Cap de Prudelles, and Säsebühl, these minerals have the formula, $\ddot{\mathbf{R}}^2\,\ddot{Si}^3+9\dot{\mathbf{H}}$, which may be also written, $(\dot{R})^3\,\ddot{Si}+2\ddot{\mathbf{R}}\,\ddot{Si}$. This formula agrees essentially with that of pyrargillite (which see), and with that of the other minerals there cited. In bole however, $(\dot{R})$ consists almost entirely of water, (24 per cent.,) with minute quantities of magnesia and lime.

15. *Iron lithomarge.* (Schüler.)

$$\left.\begin{matrix}21{\cdot}64 : 14{\cdot}65 : 6{\cdot}55\\ 21{\cdot}00 : 14{\cdot}00 : 7{\cdot}00\end{matrix}\right\}\quad (\dot{R})^3\,\ddot{Si}+2\ddot{\mathbf{R}}\,\ddot{Si},$$

formula of the preceding mineral, and others referred to above. $\dot{R}=14{\cdot}20\,\dot{\mathbf{H}}$, $3{\cdot}04\,\dot{Ca}$, $2{\cdot}55\,\dot{Mg}$, $1{\cdot}51\,\dot{Mn}$, $0{\cdot}93\,\dot{K}$.

16. *Halloylite*, from La Vouth and Thiviers. (Dufrénoy.)

(1.) From la Vouth, 21·12 : 15·72 : 7·11.
(2.) From Thiviers, 22·39 : 15·16 : 7·27.

Mean of the two analyses:

$$\left.\begin{matrix}21{\cdot}76 : 15{\cdot}44 : 7{\cdot}19\\ 22{\cdot}00 : 14{\cdot}67 : 7{\cdot}33\end{matrix}\right\}\quad (\dot{R})^3\,\ddot{Si}+2\ddot{\mathbf{R}}\,\ddot{Si},$$

formula of the preceding mineral. In the La Vouth halloylite, $(\dot{R})$ consists entirely of water (24·83), but in that from Thiviers, of 22·30 $\dot{\mathbf{H}}$ and 1·70 $\dot{Mg}$.

17. *Mountain Soap*, from Thuringia. (Bucholz.)

$$\left.\begin{matrix}22{\cdot}86 : 14{\cdot}83 : 6{\cdot}21\\ 22{\cdot}00 : 14{\cdot}67 : 7{\cdot}33\end{matrix}\right\}\quad (\dot{R})^3\,\ddot{Si}+2\ddot{\mathbf{R}}\,\ddot{Si},$$

formula of the preceding mineral. There are also altogether, independent of epidote and meionite, seven different minerals possessing the same formula, namely, fahlunite, esmarkite, pyrargillite, bole, iron lithomarge, halloylite from La Vouth and from Thiviers, and mountain soap from Thuringia. The various but isomorphous nature of $(\dot{R})$ and $(\ddot{\mathbf{R}})$, and the different grades of crystalline development, appear to form the leading differences subsisting between these minerals. Epidote and meionite cannot however be held to be isomorphous with the other minerals of this group, inasmuch as in them $(\dot{R})$ consists essentially of *lime*.

18. *Halloysite.*

(1.) From Liege, according to Berthier,
23·35 : 18·24 : 4·74.

(2.) From Guatequé, according to Boussingault,
23·90 : 18·78 : 4·94.

(3.) From Bayonne, according to Berthier,
24·26 : 17·28 : 4·74.

(4.) So-called tuesite, according to Thomson,
23·1 : 18·87 : 4·00.

Mean of these four analyses:

23·63 : 18·29 : 4·48 }
23·00 : 18·40 : 4·60 } $(\dot{R})^3\ddot{S}i+4\ddot{A}l\ddot{S}i$,

formula of diploite, (according to Rammelsberg.) In the three halloylites, $(\dot{R})$ consists entirely of water, in tuesite $(\dot{R})=13{\cdot}5\,\dot{H}$, 0·7 Ca, 0·5 Mg.

19. *Gilbertite.* (Lehunt.)

23·46 : 19·47 : 3·16 }
23·50 : 20·14 : 3·36 } $(\dot{R})^3\ddot{S}i+6\ddot{R}\ddot{S}i$.

1·98 *loss.* $(\dot{R})=4{\cdot}17$ Ca, 1·90 Mg, $4{\cdot}25\,\dot{H}$.

20. *Cerolite.* (Maak.)

19·72 : 5·69 : 13·16 }
19·50 : 6·50 : 13·00 } $2(\dot{R})^3\ddot{S}i+\ddot{A}l\ddot{S}i$,

formula of massive gehlenite, and of the Sala mica. $(\dot{R})=31{\cdot}00\,\dot{H}$, 18·02 Mg.

21. *Chonikrite.* (v. Kobell.)

18·54 : 7·99 : 15·24 }
19·00 : 7·60 : 15·20 } $4(\dot{R})^3\ddot{S}i+\ddot{A}l\ddot{S}i$.

$(\dot{R})=22{\cdot}50$ Mg, 12·60 Ca, 1·46 Fe, $9{\cdot}00\,\dot{H}$.

22. *Mountain Soap*, from Arnstedt. (Ficinus.)

21·00 : 11·62 : 14·25* }
12·00 : 12·00 : 12·00 } $(\dot{R})^6\ddot{S}i+\ddot{R}^2\ddot{S}i$.

$(\dot{R})=3{\cdot}1$ Mn, 1·1 Ca, $43{\cdot}0\,\dot{H}$.

The above mentioned *amorphous minerals*, which hitherto have all been looked upon as hydrates, receive by the introduction of the water as a basic constituent, very simple formulæ, in close agreement and harmony with those of other silicates.

(To be continued.)

* Is 21·00 a misprint for 12·00? From the formula, this latter number is correct in the lower line.

ART. VII.—*On the Construction of Blast-furnaces for the Smelting of Iron with Anthracite;* by S. S. HALDEMAN, of Columbia, Penn.*

THE occurrence of inexhaustible strata of anthracite coal in Pennsylvania, has attracted the attention of miners and practical men generally, to its use in smelting iron. With charcoal, this process requires a peculiar location, and a large capital, to be invested in extensive woodland tracts, which are generally mountainous, and consequently cheaper, being unfitted for agriculture. This renders the construction of the necessary roads difficult, and transportation expensive. The number of workmen employed in wood-cutting, coaling, and hauling, is large, and the expense of horses and wagons, forms a considerable item. Charcoal being a soft, porous material, much of it is wasted in transportation and handling, and large sheds are required to store and keep it dry. These various contingencies require the general manager to have industry, judgment, and good business habits. In using anthracite, the exact expense of the fuel is known, the transportation being by railways or canals extending to most of the mines, and if the furnace is placed near such public works, there will be but little waste of coal in its final transportation. There is but little waste in the transportation of ore, which is of course common to both kinds of fuel.

The earlier attempts at smelting iron with anthracite in the ordinary furnace, failed so completely, that it was by some deemed impossible to accomplish it; while others, looking to a different construction for a solution of the problem, devised various structures, more remarkable for ingenuity than utility; later experiments having proved that no such modifications are necessary, except perhaps a higher inclination of the bosh and a less contracted tunnel-head.

Incandescent anthracite has the peculiarity of being rapidly extinguished when struck with a blast of cold air, the loss of heat from this source exceeding that resulting from combustion; and although this phenomenon does not take place when the temperature exceeds a certain point, the vast accession of cold air in a blast furnace, may be sufficient under slightly unfavorable conditions, to produce it at any time. Hence a hot blast, which is economical when charcoal is used, becomes an essential element of success with anthracite; and its temperature should not be less than is sufficient to smelt a slip of lead opposed to a jet of it near the twiers. Anthracite being a very dense and

* The figures given in connection with this article, represent the structure of the Chikiswalungo Iron Furnace, at Columbia, owned by Messrs. Haldeman.—EDS.

concentrated fuel, the amount of air thrown in must be much greater than when charcoal is used. Success, therefore, depends upon the quantity as well as upon the temperature of the blast.

The necessary amount of oxygen can be secured only by means of the proper machinery, and a certain velocity of the blast; and in consequence of this fact, the false opinion that the effect depends merely upon the velocity or sharpness of the jet, is universally maintained. In consequence of this view, the exit pipe is reduced to a small size, and the quantity secured by increased velocity under a high pressure; which causes much of the blast to be lost, as among the multitude of joints to be made air-tight, it is impossible to secure them all. Besides this, the machinery is liable to injury from the great and unnecessary strain upon it.

The stack or main structure of a blast furnace, is a quadrangular pyramid, the lower portion of which has an arched passage through the middle of each side, leaving four large piers of masonry. Three of these passages (A, fig. 1) are named twier-arches. The junction of these arches forms an open square about one-third the diameter of the stack, in which the hearth, (which requires renewal from time to time,) is built up with large cut stones of siliceous conglomerate or sandstone. Near the top of the hearth, the inner portion of the four arches is closed by forming a square with eight large sows or iron beams, four of which are shown in section at S in fig. 2, their position nearly corresponding with the dotted square in fig. 1. The dotted circle in fig. 1, indicates the internal face of the fire-brick lining (*l*, fig. 2) at its widest part, and also the top of the bosh,* (*b*, fig. 1, 2.) The lining being circular and the lower portion a square, the former is supported upon four plates (*q*) of such a form as to close the angles of the latter, and at the head of the furnace it is continued in an ordinary brickwork chimney, (*z*, fig. 3,) leaving one or two large vacant spaces for the purpose of filling. The chief use of this chimney is to protect the workmen from the heat.

The two posterior piers have a circular passage (fig. 1, 2, *g*) for the admission of the blast pipe, *p*, which descends from the hot-oven (*o*, fig. 3) at the head of the stack. This passage is sometimes continued through the front piers, which renders the front or working arch, cooler, and gives more ready access to the twiers. The blast pipe is carried by appropriate branches to the posterior and lateral twiers, *t*, *t*, *t*, fig. 1, the former being seen in longitudinal—and one of the latter in transverse section, at *t* in fig. 2.

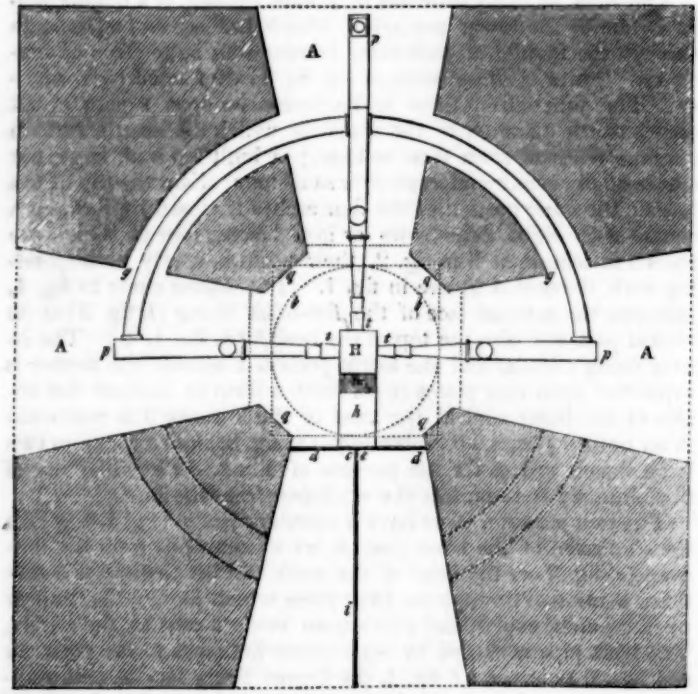
To prevent the twier from being destroyed by contact with the fire of the hearth, it is made of an interior and exterior cone of wrought iron, with a stream of water circulating between

* This word is from the German word böschung, a *slope*.

them. The twier receives the nozzle, and this the belly-pipe, which is attached to the terminal upright portion of the blast-pipe, called the ball-and-socket joint from having a connexion of this kind. Behind this, at *k*, there is a small aperture, to insert an iron rod to detach any slag that may cling to the twier. As the smelted materials within the hearth frequently rise above the twiers, it is evident that, in case the blast should be accidentally checked, they would flow into the blast-pipe. To prevent this, a valve (*v*, fig. 2,) is interposed, which is kept open by the blast, but falls the moment the pressure is removed.

The cavity of the hearth, (H*h*, fig. 1, 2) where the metal is reduced and retained, bears a very small proportion to the size of the stack. In the figures, which are drawn to a scale of one-eighth

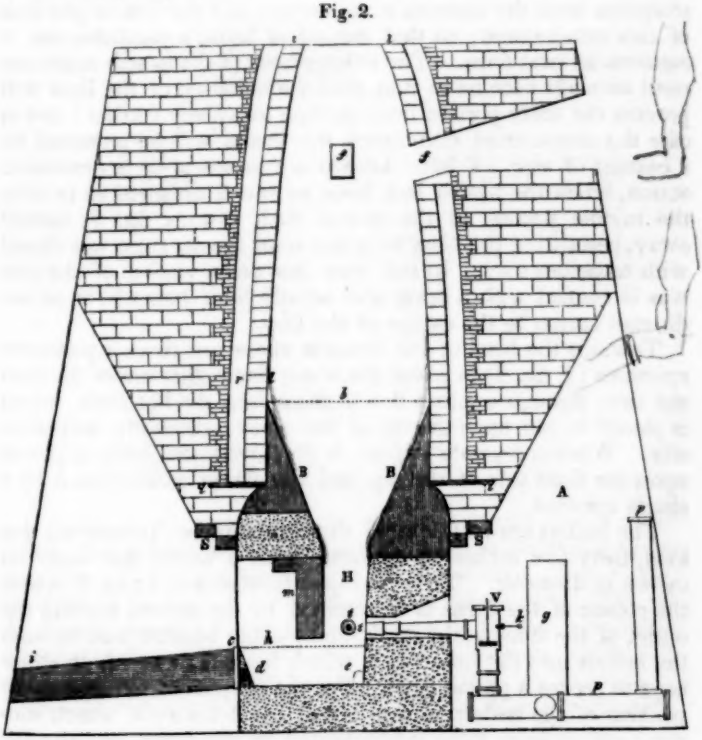
Fig. 1.



of an inch to a foot, it is two feet wide, and five and a half feet long, but enlarges upwards in a slight degree. The back and front of the hearth are separated by a partial partition called the temp, (*m*, fig. 1, 2,) made of fire-bricks, and which does not extend to the bottom of the hearth. The horizontal dotted line, (*h*, fig. 2) shows the level to which the smelted materials can rise

before running over the dam-stone (*d*) at *c*, where the cinder will escape first, being the lightest, whilst the smelted iron occupies the bottom. To prevent the fluid matter from being forced out by the blast, clay is rammed beneath the temp, around the twiers, and upon the surface, at *h*, where it is retained by heavy iron plates, which are raised every few hours, to allow the cinder to run off along the level of the top of the dust-plate *c*, *i*, whilst the metal is run off every twelve hours, at the lower level of *d*, through an aperture at the bottom of the dam-stone. The dam-stone is defended in front by a large iron dam-plate (*de*, fig. 1) against which the dust-plate *c*, *i*, rests. The lower edge of the latter rests upon the ground, which is raised to about the level of the bottom of the hearth *d*, *e*.

Fig. 2.



Explanation of Figs. 1, 2.

A, twier arches.	*e*, tapping place.	*k*, twier key.	*q*, square of the hearth.
B, bosh.	*f*, flues for boilers.	*l*, lining.	*r*, space for loam.
b, greatest diameter.	*g*, passage.	*m*, temp.	*s*, sows.
c, cinder run.	*Hh*, hearth.	*n*, sconsh'n.	*t*, twiers.
d, dam-stone & plate.	*i*, dust-plate.	*p*, blast-pipe.	*v*, valve in blast-pipe.

Fig. 2 would represent a transverse section of the stack, if the left half were symmetrical with the right. In this case the temp *m*, and the open space in front of it, would be filled with stone to the bottom of the hearth, and *e* would represent the place of exit for the iron.

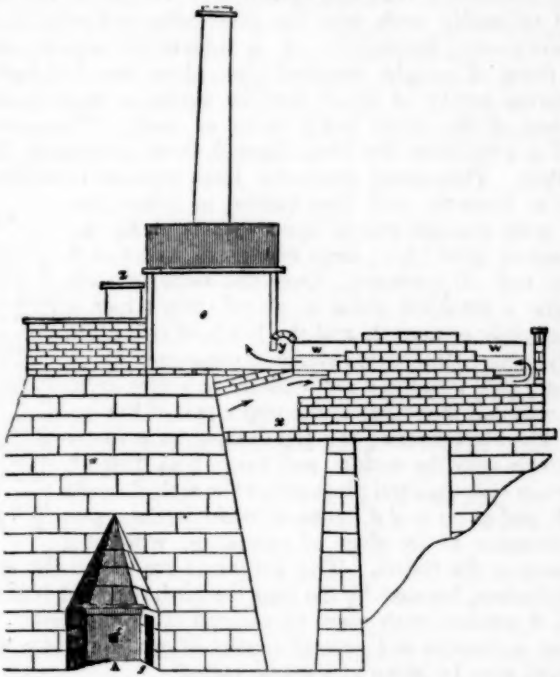
The bosh B B, fig. 2, (shaded vertically,) resembles a large funnel, except that its termination at H, fig. 1, 2, is square. It is built of fire bricks, except its lower portion in front, where, in consequence of the open temp arch (*m*), a large stone (*n*) called the sconsh'n, is laid across the front portion of the hearth. The inclination of the bosh is seen to be at a higher angle than when charcoal is used; but it may vary considerably without affecting the result. When in blast a few months, the bosh increases in steepness from the abrasion of its surface, and the hearth partakes of this enlargement; so that instead of being a parallelogram, it assumes an oval form. The enlargement of the hearth continues until its walls become so thin, that the radiation of the heat will prevent the inner portion from melting away any further; and in case the temperature diminishes, the inside will be protected by a coating of slag. I have known a furnace to be in successful action, when the hearth had been so much enlarged as to have the middle portion of the inmost back sow (*s*, fig. 2) melted away, permitting the blast to escape until the aperture was closed with tenacious clay. In this case the under surface of the sow was in contact with a brick wall usually built beneath, as an additional barrier to the escape of the heat.

Towards the head of the furnace, there are three equidistant apertures (*f*, fig. 2) to admit the waste flame, first under the boilers, then through a return flue in them into the hot oven, which is placed in part upon the top of the stack posteriorly and laterally. When a separate engine is employed, the oven is placed upon the front side of the top, and the flame passes into it by a single aperture.

The boilers are in this case three in number, twenty-six feet long, forty-five inches in diameter, with a return flue eighteen inches in diameter. They are represented at *w w*, in fig. 3, where the course of the flame is represented by the arrows leaving the outlet of the flues in the stack, and passing beneath and through the boilers into the hot-oven *o*, which has one or two high chimneys to secure a proper draft. For the purpose of exhibiting the position of the boilers, a part only of the brickwork which supports and encloses them is represented in the figure, and the minor details of construction are omitted. Figure (3) is an elevation and partial section of the right side of fig. 1, 2, showing a twier arch, with the aperture for the admission of the blast, the parapet upon the top, and the chimney (*z*) around the tunnel-head. The engine is placed upon the ground on this side, the

boilers extending to the bank against which the structure stands. When the convenience of a bank or hill cannot be had, it is evident that both the boilers and oven might be placed on or near the ground, if the chimney were sufficiently high, (not less than seventy feet,) and the walls built so as to be free from crevices.

Fig. 3.

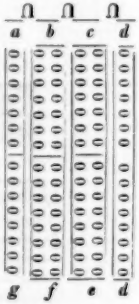


The boilers are supported upon large iron beams, (partly shown below *x*,) between which arches are turned in their longitudinal direction. There are several doors in the position of *x*, to allow the flues to be cleared from ashes, &c. These doors open into the arches beneath, and there are others along the sides for the same purpose. The boilers are usually placed in contact with the oven; but the passage *y* (which extends to the chimneys) is proposed to be left to turn more or less of the flame into the chimneys, which will place the relative distribution of the heat to the oven and boilers under control, a point which seems not to have been hitherto attained. This might also be accomplished by separate chimneys to the oven and boilers. In either case, the chimneys must be supplied with a damper, which is best placed upon the top.

If four simple boilers were used, the flame might be passed under one pair and return under the other; or, the oven might be placed upon the bank, which would afford a good foundation for it and its chimneys; but the distance which the heated blast would be required to travel before reaching the twiers, would be an objection.

The hot-oven is built and arched over with brick, and strongly bound externally with iron, the heat being sufficient to destroy supports passing through it. It is sufficiently large to contain a small forest of upright flattened pipes about ten feet high, with an internal cavity of about four by seven or eight inches, the thickness of the metal being about an inch. These are maintained at a red heat, the blast through them preventing their destruction. They stand upon two large pipes or cylinders about a foot in diameter, and from twelve to fifteen feet long, with a single row of apertures, (*a*, *d*, fig. 4,) and one or more (*b*, *c*) large enough to admit of a double row of apertures. Over the neck of each aperture, a detached collar is placed, into which a pipe is firmly cemented, and the heads of two pipes on adjoining cylinders are similarly connected by an auxiliary pipe forming a semicircular or gothic arch, as represented in section in the upper part of the figure. The blast entering the first cylinder at *a*, meets a partition near the middle, and has to pass through the seven openings and pipes across the arched heads into *b*, and so on to *d d*, when it passes in the opposite direction to its place of exit at *g*, whence it descends to the twiers. The partitions are not in the middle of the cylinders, because by the time the air has passed half through them, it requires more room on account of its expansion.

Fig. 4.



The operations and general results of smelting iron with anthracite, may be given at a future period.

ART. VIII.—*Notes on some Ferns of the United States;* by Professor KUNZE of Leipzic, 1846.—(Communicated by Dr. G. ENGELMANN.)

THE plants of this family prefer the climate of ocean-islands, more particularly within the tropics; the number of species is very limited on the large continents, especially in cold or temperate latitudes. We observe the same fact in the United States; the ferns of which are not numerous, though it is supposed that in the western and southern parts of the union, several may yet be discovered. Several species new to the flora of the United

States have been communicated to me; their description, and some further notes on some North American ferns, are here offered to the botanists of the Union, who will oblige me exceedingly by communicating ferns, not known to me, and thereby assist my investigations on this family.

The most complete enumeration yet known to me is that of Nuttall's, (1818,) and the largest supplement has been furnished by Hooker (Flora Bor. Am., 1840). Many other data may be gleaned from numerous journals and other works, to collect and arrange which will be the task of some American botanist; I here offer merely some notes on the distinction of nearly related ferns, on some additional localities, and a few special remarks, in which I follow Nuttall's arrangement.

Equisetum.—I have nothing to add to A. Braun's and Engelmann's memoir in this Journal, vol. xlvi.

Lycopodium.—*L. Selago*, L., found in Greenland, on the mountains of New England (E. Tuckerman, Jr.), and on rocks at the falls of Broad River, North Carolina (Rugel!).—*L. alopecuroides*, L., on meadows between Quincy and Aspalaga, Florida (Rugel!). An elongated form densely covered with small leaves was collected on Lake Tamony, Florida, by Rugel!—A similar elongated variety is *L. inundatum*, L. β. *Bigelovii*, Tuckerm.! (*L. Carolinianum*, Big., *L. Bigelovii*, Oakes and Tuck.!) from Plymouth, Mass. (Tuckerman!), and from Covington, Louisiana (Drummond!).—*L. annotinum*, L. β. Spach Monogr. (*L. pungens*, Desv., L. annotinum, β. montanum, Tuckerm.! L. sabinæfolium, Beck, non Mich. fide Tuckerm.) has been found, not only in Newfoundland and Labrador, but also on the White Mountains of New Hampshire (A. Gray! and Tuckerman!).—*L. dendroideum*, Mich. (*L. obscurum*, L.) has been found as far south as the Smoky Mountains of Tennessee (Rugel!).—*L. Chamæcyparissus*, A. Braun,* nearly related to *L. complanatum*, L., but probably well distinguished, grows also on the Chivi Mountains, Cherokee County, North Carolina (Rugel!).—*L. lucidulum*, Mich., one and a half feet high, New England, (Tuckerman!) of common size on the Black Mountains, North Carolina (Rugel!).—*L. rupestre*, L., is widely distributed in America and Africa, and from California to Mexico and Peru. Beyrich has collected it in the Southern States, and Rugel on the Broad river Mountains, North Carolina.—Nuttall's supposition, that *L. albi-*

* Note by A. Braun.—*L. Chamæcyparissus* is preserved in Wildenow's herbarium from Canada, sent by Richard under the name of *L. complanatum*. *L. complanatum* of the North American authors belongs mostly to *L. digitatum*, (Dillen,) A. Braun; it is questionable whether the true Linnean *L. complanatum*, has been found in North America; a specimen collected in Kamtschatka by Ermann cannot be entirely identified, as it shows no fructification. *L. sabinæfolium* is a very doubtful species of this section. To judge from a specimen in Willdenow's herbarium, I take it to be an alpine form of *L. Chamæcyparissus*.

dum might be only a variety of *L. apus* or *apodum* has lately been confirmed.

Ophioglossum.—American specimens of *O. vulgatum* are not distinct from European ones.—A small species with an elliptical acute leaf as long as the spike, collected by Beyrich at Ebenezar, probably belongs to *O. nudicaule* (*O. ellipticum*, H. and Grev.)—A specimen of *O. bulbosum*, Mich., or more properly *O. crotalophoroides*, Walt., collected by Drummond in Louisiana and communicated by A. Gray, agrees exactly with *O. tuberosum*, Hook. from Talcahuano.—*O. pusillum*, Nutt., is entirely unknown in Europe and has not been mentioned by Greville and Hooker. Bot. Misc., iii.

Botrychium.—The different species still require to be more accurately distinguished. *B. gracile*, Pursh, has been united with *B. virginicum* by Greville and Hooker. (l. c.) *B. dissectum*, Muhl., is unknown to me.

Osmunda.—A. Gray has already proved the identity of *O. Claytoniana*, L., with *O. interrupta*. *O. spectabilis*, W., and *O. regalis*, L., cannot be separated any better. Nuttall has already pronounced them "scarcely distinct."

Polypodium.—More correct observations are required regarding the species which resemble *P. vulgare*, L. *P. vulgare*, *β. americanum*, Hook., (*P. virginianum*, L.,) differs from the European form by a narrower and more elongated frond, narrower lobes separated by wider sinus, the lowest being longer or at least not shorter than the following ones, and the sori being always nearer the margin than in the European plant. I have not met with any American specimens entirely agreeing with the true *P. vulgare* of the old world.—*P. Scouleri*, H. and Grev., Ic. Fil. 56, is incorrectly united with the very distinct *P. Californicum*, Kaulf., in Hook. Fl. Bor. Am. *P. intermedium* is unknown to me; it appears to approach *P. Cambricum*, Desv., the original form of *P. Cambricum*, L., and of the gardens, a common fern about the Mediterranean Sea, but may constitute a separate species.—*P. incanum*, L., appears to belong exclusively to the southern states, I have seen specimens from Louisiana (Flügel!), and from Louisiana and Florida (Rugel!).*—*Polyp. connectile*, (Mich.,) not distinguishable from *P. Phegopteris*, L., extends as far north as Newfoundland and Labrador.—*P. Dryopteris*, L., was sent to me from Labrador.—*P. calcareum*, Sm., widely differing from the last, is enumerated by Hooker; I have not seen any American specimens of it.

Nothochlæna *dealbata*, Kunze, (*Cheilanthes dealbata*, Pursh, ii, 675, Nuttall, ii, 253, *N. pulchella*, Kze., in Mohl and Schlechtend., Bot. Zeitg., 1843, No. 37,) must be introduced here. This

* Grows as far north as on the Wabash in Indiana.—*Engelm.*

species is nearly related to *N. nivea*, though essentially distinct. I have only seen specimens obtained from the Berlin botanical garden, but Nuttall's and Pursh's diagnoses do not permit a doubt about the identity of the species. I would not have looked for it under *Cheilanthes*.*

Woodsia.—I cannot distinguish *W. rufidula*, Beck, (*Nephrodium*, Mich.,) from *W. ilvensis*, Br. The species varies, with ovate, acutish, elongated, obtuse or rounded fronds. Specimens from New York, sent by Prof. A. Gray, attain the height of six inches.—*W. glabella*, Br., Hook. Fl. Bor. Am. i, 237, is a very distinct species.

Physematium.—*Ph. obtusum*, Hook. Fl. B. Am. ii, 259. Hooker in Spec. Fil. i, 62, very properly unites *Aspidium obtusum*, W., and *Woodsia Perriniana*, Hook. and Grev., though under the name of *Woodsia obtusa*. This fern extends from the north-eastern states to North Carolina, Missouri and Texas.

Aspidium.—I have so far seen no specimens of *A. cicutarium*, Spreng., from the United States.—Hooker refers *A. Filix mas*, Pursh, to *A. Goldianum*, H. and Grev., whether correctly or not, I cannot decide; but I have seen the true *A. Filix mas* from Newfoundland.—*A. molle*, Sw., appears to be unknown as an inhabitant of the United States; I have seen specimens from Louisiana, (Ludwig in Herb. Lucæ!), Alexandria, Louisiana, (Hale!) limestone rocks near Aspalaga, Florida (Rugel!), and banks of streams near Houston, Texas (Lindheimer in Herb. A. Braun!).—*A. Thelipteris* and *A. Noveboracense*, Sw., are declared by Hooker, Fl. Bor. Am., to be "quite identical." I cannot subscribe to this opinion. The latter species, Schk., t. 46, appears to me to be distinguished from the former by a shorter stipe, by the circumference of the frond being more narrowed upwards and downwards, by thinner texture, by narrower and ciliate segments of the pinnæ, and by entire veins (Presl therefore arranges both species in different sections of his genus *Lastrea*). I have seen *A. Noveboracense* from New York (Halsey), Pennsylvania, (Pœppig), Arkansas (Beyrich), and North Carolina (Rugel).—I have seen no North American specimen of *A. cristatum*, Sw.—The identity of *A. spinulosum*, Sw., *A. dilatatum*, Sw., *A. dumetorum*, W., and *A. intermedium*, W., as different forms of one species, cannot be doubted any longer. A peculiar variety of *A. spinulosum* occurs in the northern latitudes and on the mountains of the Southern States, which must be studied more closely in its native localities, as it may prove to be a distinct species. I have specimens of this form from Newfoundland, (La Pylaie,) Greenland, and Labrador,

* *Nothochlæna sinuata*, Kaulf. Enum. Fil. 135. Kunze, t. 65. (*Acrostichum sinuatum*, Sw. Syn. Fil. *Gymnogramma sinuata*, Presl.) so far only known as a Mexican and Peruvian species, has been found by M. Lindheimer on the Guadaloupe river in Texas.—*A. Braun.*

(Breutel and Kurr,) New England mountains, sterile (Tuckerman), and from the highest tops of the Black Mountains, North Carolina, (Rugel). Cultivated specimens have been communicated to me from the botanical garden of St. Petersburg, (Dr. Fischer as *A. spinulosum americanum,*) and from that of Berlin. The lowest pair of the mostly opposite pinnæ is *ascending* and *curved upwards*, and has a *different direction from the other pinnæ*. The pinnulæ are more deeply pinnatified, with more and sharper teeth than in the common form; *those of the lowest pinnæ, especially near the base, are much elongated downwards*, by which these pinnæ assume a very irregularly triangular shape. The sori are nearer the middle nerve. The stipe is thickly covered with brown or redish paleæ. If this form should eventually prove to be a distinct species, the name of *A. campylopterum* would be appropriate.—*A.* (*Polystichum*) *Lonchitis*, Sw., also in Greenland (Wormskiold).*—*A.* (*P.*) *aculeatum*, to which Hooker (Fl. Bor. Am. ii, 261,) joins even *A. vestitum*, Sw., though undoubtedly incorrectly, and *Nephrodium setigerum*, Presl, which I do not know, appears to include different species, which I think ought to be separated. But Hooker states that the plant of the Rocky Mountains and the Pacific coast is intermediate between *A. lobatum* and *A. angulare*, and is identical with *A. aculeatum* of his British flora. All the American specimens which I have seen were communicated by Mr. E. Tuckerman, as collected on the mountains of New England. They evidently belong to *A.* (*P.*) *Braunii*, Spenn. Fl. Frib., which, therefore, is also an American plant. The different species which usually have been confounded under the name of *A. aculeatum* have been elucidated by me in a memoir, which is not yet published. I have thus far seen *A. Braunii* only from Baden and Saxony, and from New England. Prof. Braun states that it has also been observed in Norway: it is cultivated in the botanical gardens of Leipzig and Berlin.—I have to add here a new and well distinguished species of the United States.

A. (*Polystichum*) *Ludovicianum*, Kunze: fronde tenuiter coriacea, glabra, oblongo-lanceolata, bipinnata; pinnis (alternis) remotis, oblongo-acuminatis, patenti-erectis inferioribus petiolatis; pinnulis basi adnatis decurrentibus, sterilibus ovato-oblongis acutiusculis serrulatis subsinuatis, fertilibus e basi inæquali subauriculata leviter falcatis lanceolato-oblongis grosse sinuato-dentatis, infimis pinnatifidis, laciniis dentibusque 1–raro 2–sorophoris, obtusis; costulis subtus convexis; soris magnis, convexis, centro ab indusio badio leviter impressis; rhachibus partialibus marginatis, universali stipiteque stramineis, rufo-paleaceis.

In Louisiana legit Ludwig (Herb. Luceanum!). Colitur in horto botanico Berolinensi (vid. specimen!).

* It likewise occurs on the shores of Lake Superior.—A. Gr.

A fine species, which cannot be confounded with any one known to me; in habit it approaches somewhat to *A. (Nephr.) marginale;* it is 1–2 feet high; the circumference of the entire fertile pinnulæ varies from lanceolate to oblong; the veins are repeatedly furcate and the upper branch rarely: also the following bear the sori; the sterile branches of the veins end just before reaching the margin only slightly thickened.

Onoclea.—*O. obtusilobata*, Schk., according to Hooker's opinion, a variety of *O. sensibilis*, and

Struthiopteris *Pennsylvanica*, W., which the same author declares to be synonymous with *S. Germanica*, W., are not well known to me. An examination of specimens in the royal herbarium of Berlin, inclines me to the same opinion. The genus *Rhagiopteris*, Presl, is founded on fertile specimens of *Onoclea*, mixed with sterile ones of an *Aspidium*.*

Asplenium.—*A. pinnatifidum*, Nutt., appears to be a rare species.†

Rugel has collected a variety with sharply and irregularly incise-toothed lobes, on rocks of the southern declivity of the Broad River mountains, North Carolina. It is distinguished from *A. rhizophyllum* by its free, not anastomosing veins, and apparently also by never being proliferous from the tip. Mr. Shuttleworth states that *A. rhizophyllum*, *β. pinnatifidum*, Barton, in Eaton, Manual, ed. 5, 120, is the same plant.

A. trichomanoides, Michx., fronde coriacea, glabra, linearilanceolata, brevi-acuminata, basi longe attenuata, pinnata; pinnis sessilibus (oppositis), divergentibus, trapezio-oblongis, obtusis, inferioribus deflexis subcordatis sensim abbreviatis, omnibus subaveniis, margine cartilagineo repando-crenatis; soris breviusculis, margine approximatis; rhachi stipiteque brevi basi paleaceis, rhizomate brevi, horizontali, radicoso.

This species, so well distinguished from its nearest relatives, has been much mistaken. Michaux's diagnosis and his habitat "Carolina" permit no doubt but that the plant collected in Georgia and Tennessee by Beyrich, and about Dandridge, Tennessee, by Rugel, and described above from their specimens in my herbarium, is the same as Michaux's. Michaux (Fl. Bor. Am. ii, 265) refers to two figures: 1. Plukenet (Almag.), p. 152, (Phytogr.) t. 287, f. 2; [Michaux's citation is not exactly the same, but these are Kunze's words and figures,] and 2. Morrison, p. 567, part. xiv, t. 2, f. 12. var. minor. The latter figure, though rude, represents tolerably well the plant in question, but the former must remain doubtful, for the pinnæ are represented as being auriculated

* As was pointed out in a notice of Presl's Pteridographia, in this Journal, vol. xxxix, p. 174.—A. Gr.

† Grows also on sandstone rocks near Mine la Motte, in southern Missouri.—*Engelm.*

above and below. Swartz, in his Synopsis, p. 79, and 272, refers Michaux's plant, together with the quotations, to *A. polypodioides;* but he seems to have had some other plant in view, in drawing up his description, perhaps a form of *A. ebeneum*, or to have mainly considered Plukenet's figure; as he says, *pinnæ basi utrinque obtuse auritæ*, and as he leaves out Michaux's words, "*fructificatione lineis brevissimis*," and as he says in the description, "sori lineares, brevissimi, ad latera costæ utrinque puncta Polypodii mentientes, ætate confluentes." Schkuhr has only considered *A. ebeneum*, and has figured it as *A. trichomanoides*, tab. 73. The largest specimens of the true plant, seen by me, are only six inches high, while Swartz mentions his as being 1–2 feet high, nor did I ever see the sori confluent. *A. trichomanoides* of the English gardens is nothing but *A. Trichomanes*. As Swartz's alteration of Michaux's name is entirely gratuitous, the latter must be restored to this species.

A. melanocaulon, W. and *A. Trichomanes*, are united by Hooker, nor can I satisfactorily distinguish them. *A. montanum*, W., which is considered a rare plant, has been collected in abundance in N. Carolina, by Rugel, and in Georgia, by Beyrich.* *A. Adiantum nigrum*, Michx., belongs here. I have not seen any American specimens of the true *A. Filix fœmina;* it appears to be represented by *A. Michauxii*, Spr. (*A. Filix fœmina*, Mich., *Aspid. angustum*, W.), and by *A. Athyrium*, Spr. (*Aspid. asplenioides*, W.), the latter extends as far north as Labrador and Newfoundland. Both these species, which are certainly well distinguished, are thrown together by Hooker. The Mexican *A. Michauxii*, Mart. and Gal., is a distinct species which I have named, *A. Martensi*. My *A. Sibiricum* (*Aspid. crenatum*, Sommerfelt) may yet be discovered in arctic America.

Pteris.—*P. pedata*, of the North American Flora, I have not as yet seen, so I am unable to say to which of the lately distinguished species it may belong, probably to *P. geraniifolia*, Raddi. *P. atropurpurea* as well as *P. gracilis*, must be referred to the genus *Allosurus*. *P. caudata* of the United States, is not the true Linnæan plant which is common in South America, and the West Indies, and is distinguished by the nodose base of the rhachis, as has already been stated by J. Agardh, Monogr. Pterid. 49, but a variety of *P. aquilina*, L., Schk., t. 96. b., peculiar to North America, which Desvaux, Prodr., Fil. p. 303, has distingnished under the name of *P. latiuscula;* and which ought to be more closely studied. It occurs more or less hairy.

Allosurus.—(*Cryptogramma*, Br.) *A. gracilis*, Kaulfuss, *Pteris*, Mich., is nearly related to *A. crispus*, though distinct. I have

* And even as far east as Hillsboro', North Carolina, by the Rev. Mr. Curtis. A. Gr.

received numerous fine specimens of it from rocks, New York, by Dr. Knieskern. *A. acrostichoides*, Pr., is unknown to me; and Hooker is probably correct in referring it to *A. crispus*.

VITTARIA.—Not having compared any North American specimens, I am unable to say whether they belong to the true *V. lineata*.

BLECHNUM.—*B. boreale* is a *Lomaria*.—*B. serrulatum*, Mich., I have only from South America.

ADIANTUM.—*A. Capillus*, diffused over almost the whole globe, is also not rare in the southern U. States, where Beyrich collected it (the label does not give the exact locality); Dr. Engelmann sent it from the Hot Springs of Arkansas; Rugel from Aspalaga, Florida; and according to E. Tuckerman, it is also found in Alabama.

CHEILANTHES.—I refer to this genus Buckley's *Pteris Alabamensis*,* and name it *Ch. Alabamensis*. It is a very distinct species, which has also been collected by Rugel on French Broad River, Tennessee, and is preserved in Shuttleworth's herbarium from Capville, Upper Georgia; it is now also cultivated in the Leipzic botanic garden. It resembles *Ch. micromera*, Sw.; and my *Ch. Linkiana* (*Ch. micromera*, Link), *Ch. vestita*, Sw. (*Nephr. lanosum*, Mich.), appears to be common in the southern states. I have seen specimens collected by Beyrich near Augusta, Georgia; by Leibold on the western frontiers of Arkansas; by Duerinck in Missouri, in Carolina, (Schweinitz,) and on the Broad River Mountains, North Carolina, by Rugel. *Ch. tomentosa*, Link, (Fil. Spec. h. bot. Berol, p. 65, raised from Mexican spores, now common in European gardens, is new for the flora of the United States. Rugel collected a few specimens with the former in North Carolina, and Prof. A. Gray has sent me specimens from Tennessee under the name of *Ch. vestita*. Cultivation does not alter it in the least. It is quite probable that some of the numerous species of Mexico may yet be discovered in the southern states.† *Ch. dealbata*, Pursh, is a *Nothochlæna*, (see above.)

DICKSONIA.—Michaux's name, *Nephr. punctilobulum*, not as commonly spelled, *punctilobum*, has the priority (1803); Schkuhr's name, *Dicks. pubescens*, was published 1809, and Willdenow's, or rather Muhlenberg's MSS. name, *Polypod. pilosiusculum*, dates only from the year 1810. Desvaux has founded his genus *Litolobium* (not *Sitolobium*), Prodr. 262, on this species; but the peculiar characters are not sufficient to warrant a generic separation, and I refer with Hooker this plant again to *Dicksonia*, and name

* This Journal, 1843, p. 177.

† On the calcareous rocks of the Hot Springs of Arkansas, I collected together with *Ch. vestita*, a second species, which Prof. A. Braun considers identical with the West Indian *Ch. microphylla*, Sw.—*Engelmann*.

it *D. punctilobula*. I have specimens from the West Indies, (Ryan,) Tennessee and North Carolina, (Rugel!) Ludwig collected in Louisiana a fern, specimens of which I received from Lucæ's herbarium, and which resembles very much *D. punctilobula;* but it has more acutely dentate segments, rhachis and veins below, sparsely covered with short hairs, very large sori without any trace of an indusium, which is still plainly distinguishable even in fully mature specimens of *D. punctilobula*. It is impossible to decide about this plant without examining younger specimens, which I hope botanists of the Southern United States will be induced to do. It may possibly be a peculiar *Polypodium?* Muhlenberg's specimen in Willdenow's herbarium, is plainly *D. punctilobula*.

Cystopteris.—*C. fragilis* has been sent by Dr. Engelmann from Missouri, (rocks on the Merrimac Springs.) The specimens sent from Labrador by Kurr and Breutel,—from the Broad River Mountains, North Carolina, by Rugel,—those from Pennsylvania and New England, seen by me, all belong to *C. tenuis*, Schott, which appears to be well distinguished from *C. fragilis*, and not a variety of it, as Hooker states; the distinguishing characters remain constant in cultivation. *C. bulbifera*, Bernhardi, grows also near Painted Rock, below the Warm Springs in North Carolina, (Rugel!)

Hymenophyllum.—I have not yet seen any North American specimens.

Isoëtes.—Prof. A. Braun has published his investigations on this genus in Flora or Bot. Zeitung, 1846, No. 12.* I have only to add to this valuable paper, that *I. lucustris* has been communicated to me by Mr. E. Tuckerman from New England. The mention made of an *Isoëtes* from California, is based on a mistake of Bory's, who speaking of *I. flaccida*, put California for Florida. *I. flaccida* has only an apparent affinity with *I. longissima*, Bory; the spores of this last are large brown, with membranaceous margin, minutely and sparsely farinaceous.

Marsilea.—I am acquainted with three North American species: *M. vestita*, H. and Gr., common on the Columbia River in Oregon, collected by Douglas and by Geyer; *M. uncinata*, A. Braun, collected by Dr. Engelmann on the banks of the Arkansas, and by Beyrich on the Washita in Arkansas; and a third species found by Drummond in Louisiana, the fruit of which I have not seen.†

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* A translation has been published in this Journal, ii ser., iii, p. 52, January, 1847.—E.

† Compare Notes on Marsileæ, in this Journal, ii Ser., iii, p. 55, Jan., 1847. Drummond's plant, mentioned by Kunze, is doubtless *M. macropoda*, Engelm., in this Journal, l. c., described from specimens collected by Lindheimer near the Matagorda Bay in Texas. *M. macropoda:* stipitibus supra basin petioli ortis pluribus (2-5), basi connatis, receptaculo ter quaterve longioribus, erectis; receptac-

Salvinia.—I have not seen this plant from the United States.

Azolla.—*A. microphylla*, Klfs., from California, is certainly distinct from *A. caroliniana*, though Hooker unites them. The latter species was collected by Drummond about New Orleans.

Art. IX.—*On the Beneficent Distribution of the Sense of Pain;* by Mr. G. R. Rowell.

Read before the Ashmolean Society of Oxford, 3d May, 1847, and communicated by the Author, to the Edinb. New Phil. Jour., vol. xlii, p. 385, from which it is here cited.

Having had, in my youth, an aversion to animal food, from an idea that it was cruel to destroy life for the purpose of obtaining it, I have been led by that feeling, and a few rather extraordinary circumstances which have come under my notice, to pay some attention to the effects produced by injuries to various animals; which investigation has caused such a complete change in my opinions on the use and distribution of the sense of pain, that, so far from considering it an infliction, I now believe it to be one of the most necessary senses we possess; that, like all other senses, it is given to animals in as great a degree as it is necessary and useful to them; that no animals have a greater sense of pain than is necessary for the preservation of the class to which they belong; that those which are designed for food, suffer little when killed, in comparison to what other animals would feel from the same infliction; and that some are totally devoid of the sense of pain.

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ulo ascendente, oblique securiformi versus basin angustato, margine superiori minore, inferiori magis convexo, lateribus compresso; rhaphide brevi, dente inferiori obtuso divergente, superiori vix ullo; receptaculo coriaceo indurato, fusco-atro, cicatricibus concoloribus scabrato, paleis angustis persistentibus tecto; soris utrumque decem; foliolis flabelliformibus, margine arcuatim excisis, apice integris, utrumque albo-pilosis.

Very distinct from the other North American Marsileæ, it approaches an undescribed species from New Holland, *M. Drummondii*, A. Braun, mss., nearer than any other. What I formerly called *stomata*, (vide this Journal, l. c.,) I find now to be nothing but the *cicatrix*, or the place of insertion of the paleæ. In the other North American species: these scars have a red margin, which is wanting in *M. macropoda*.

A fourth species is *M. mucronata*, A. Braun, collected by Geyer in the Northwestern Territory, (this Journal, l. c.)

A fifth has been collected, 1837, by T. Lindheimer in Western Texas, on the upper waters of the Guadaloupe River.

Marsilea tenuifolia, Engelm. mss.: stipitibus singulis e basi petioli ortis, receptaculo dimidio brevioribus; receptaculo ascendente, oblique obovato, margine superiore vix convexo subrecto, lateribus compresso; rhaphide brevi, dentibus approximatis superiore inferiorem paulo superante; paleis brevibus, adpressis, sparsis, cicatricibus rubro-marginatis; soris utrumque 9–10; foliolis angustis oblique lanceolatis, apice oblique truncatis, inæqualiter dentatis, parce adpressi pilosis.

Nearly related to *M. mucronata* and *M. vestita;* but distinguished by the shorter stipe, more erect fruit, and shape of the leaflets.—*A. Braun.*

In submitting this paper to the consideration of the Ashmolean Society, I beg to state distinctly, that I do not pretend to any knowledge of anatomy, but have been led to my conclusions by what appears to be the effect of injuries upon different animals. I do not attempt to assign any cause for the difference of the amount of pain, whether it be that the nerves are less sensitive, or less numerons in some classes than in others, or whether it is owing to the want of reflecting faculties, but only to show that there is such a difference.

I do not know that there is any thing new in the opinions I advance; but as I have had more than ordinary opportunities of witnessing the effect of wounds on some classes of animals, I submit this paper, believing that the consideration of the subject is calculated, in the highest degree, to excite feelings of gratitude and admiration of the merciful designs of Providence; and as the discovery of the use of the vapor of ether has recently brought the sense of pain under the consideration of this Society, I hope the paper will be in some degree interesting.

There can be little doubt that the sense of pain is of the first importance to man, to guard and warn him from injury. The skin is very sensitive, the body being thus enveloped in a membrane susceptible of the slightest injury, while the heart, lungs, brain, and other vital internal parts that are thus guarded, are almost insensible; but although the lungs are, in a great degree, insensible of pain during consumption, they are extremely sensible of the impurities of the air, thus guarding against the inhalation of anything injurious. As the hands, and especially the fingers, are very liable to injury, the sense of pain is great in those parts; and I believe there may be more real pain from a gathering in the finger, than from very many of the most fatal complaints. The exterior coating of the eye is extremely sensitive; while the back and interior portions of that organ are almost insensible. The sense of pain in the mouth guards the throat, and in the stomach is a warning against our eating anything that is injurious. Rheumatic pains are bad; but how many more fatal cases would arise from colds, &c., if man was not warned by pain and inconvenience of the bad effects upon his constitution of sudden changes of temperature.

One of the best ways to judge of the value of anything, is to consider how we could do without it; and it will be well to do so in the present case. Thus, if a man had not the sense of pain, he might sit by a fire, and in his absence of mind, put his foot upon it, and soon find himself *minus* that useful member; he might have lime blown into his eyes, and thus loose his sight if not warned by the pain; in fact, there would be no end to his dangers if not possessed of that useful monitor, which guards him from injury, and is a check to his excesses. There may be

pains and sufferings, the use of which it may be difficult to see; but I would rather attribute this to a want of knowledge, than believe that the rule which holds good in so many cases does not hold good in all. In fact, the beneficial use of the sense of pain to man is so evident, and has been pointed out so long since in Paley's Natural Theology, that I should not have said anything upon the point, but that I considered it necessary for the elucidation of my subject, as regards its uses and distribution among the lower classes of animals.

Before I enter farther upon the subject, it will be necessary to consider what may be taken as a *proof* of pain; convulsions are considered by many as a sign of suffering, but I believe it is generally allowed by the medical profession that the opinion is erroneous: the cry of animals cannot always be depended on as indicative of pain, which is proved by the noise a pig will make when taken hold of. It is also necessary to make allowance for the struggling under restraint which is natural to all wild animals. The only criterion to decide the question is to consider what is the effect of mutilations on the health of animals, and how far such injuries interfere with their usual habits and appetites.

I will now state a few cases, to show that injuries, apparently the most dreadful, have but little effect on many of the brute creation.

The first case which forcibly took my attention, was seeing a horse that was feeding by the side of the road between St. Clement's and Headington hill, have its leg broken by a coach-wheel passing over it just above the fetlock joint; the poor beast showed evident signs of pain at the moment, the bone being dreadfully crushed, and protruding in parts through the skin. A number of persons collected around, but no one liked to dispatch it, and on their standing aside, so that it might get out of the way of things passing, the moment the horse got to the side of the road it began grazing, showing no other sign of pain than holding up the injured leg.

Another case is that of a post-horse, which was going along the road between Botley and Ensham, about twelve years since, when it came down with such violence that the skin and sinews of both the fore fetlock joints were so cut that on its getting up again the bones came through the skin, and the two feet turned up at the back of the legs, the horse walking upon the ends of the leg bones. The man who was with it would not consent to its being killed till he had informed his master, (who, I believe, was Mr. Masters of Staple Hall Inn, Witney;) the horse was therefore put into a field by the road side, and was found the next morning quietly feeding about the field, with the feet and skin forced nearly half way up the leg bones, and where it had been walking about, the holes made in the ground by the leg bones were three or four inches deep.

A similar accident once happened to a coach-horse, the property of the late Mr. Costar of Oxford; it was found, when the coach stopped to change horses, to have dislocated the fetlock joints, and from the worn appearance of the ends of the leg bones, must have run a considerable distance along the road in that state.

I do not lay much stress on this case, as it is not very surprising that a spirited horse, in harness with others, should continue running under such circumstances; but in the former case, there was nothing to excite the horse but its hunger, and if the pain had been equal to what such a dreadful injury would seem to indicate, it would probably, if in ever such a famished state, have gone upon its knees to feed, rather than upon the injured parts.

It is curious to observe the apparent indifference with which some animals will devour parts of their own bodies. I once kept tame dormice, and, in shutting the cage door, accidentally caught the tail of one of them, when it squeaked out and left the skin of about two thirds of its tail sticking to the door. Whether the cry was caused by pain or fear, I cannot decide; but it went about the cage for a few minutes apparently rather uneasy, it then took hold of its tail with its paws and eat all the injured part, and then seemed as well as ever.

Rats will often eat their tails when in confinement, if kept short of food; and the habit of eating their own tails is not uncommon amongst the monkey tribe. I know a person who used to dip the end of his monkey's tail in tobacco water to keep it from being eaten, and some of the monkeys in the London Zoological Garden may at times be seen enjoying themselves in this way; but from whatever cause this propensity may arise, I believe it is never indulged in by the monkeys with prehensile tails; their tails seem to be too useful to be so wantonly disposed of, and I have no doubt are therefore possessed of a much greater share of the sense of pain.

A few years since, the Quarterly Review, in a notice of the Dean of Westminster's work on the bones found in the cave at Kirkdale, stated that an old hyena kept in the Jardin des Plantes at Paris, had its leg broken, when one night it bit off the leg at the broken part, and eat it.

The emasculation of large cattle seems a very barbarous operation, the parts being cut with hot instruments; yet I saw an aged bull after undergoing that operation, walk away very unconcernedly, and then after grazing for about half an hour, he lay down and chewed his cud apparently quite comfortable.

Pigs make a sad outcry when being killed, but I believe it is caused by fear and the uncomfortable way in which they are held, rather than by pain. I once saw a large pig which had been stuck, get away from the men who were holding it, and there was not the least cry after it had got out of their hands, al-

though it was bleeding to death; when smaller pigs are killed by sticking them, and then letting them run about till they drop, there is no cry after they are let go; and if stuck skilfully, without taking hold of them, there is no more noise than a mere grunt or squeak, about the same as there would be if the pig had a slight blow with the end of a stick; and I have no doubt that a pig may feel more pain from a heavy blow, than from being killed in the usual manner. When it is considered that the nose of a pig is so very useful to the animal from its habit of routing in the earth, and may therefore be very sensitive, it does seem probable that the opinion is correct, that a pig feels more pain from having a ring put through its nose, than in being killed.

I have stated these cases to shew that the pain felt by brutes is much less than would be felt by man under similar injuries. My object is to shew the probability, that as the sense of pain is not so necessary or useful to brutes, they have it in a less degree.

In the next class of animals to which I shall allude, that is, rabbits and hares, I will endeavor to shew that the use of the sense of pain is, in a great degree, or almost completely, superseded by other senses, and that their sense of pain is very trifling, compared to that of most other quadrupeds. There can be little doubt that, although so very prolific, very few rabbits or hares in a wild state die of old age, as they are the food of a large class of beasts of prey. Foxes, wild-cats, martins, pole-cats, stoats and weasels, could not exist without them; they are their natural prey, against the least of which the rabbit or hare has no means of defense when once caught; therefore the sense of pain would be of no use to them, either to warn them from danger or to cause them to exert themselves to escape; but a slight examination of the form of both rabbits and hares, will shew that they have other means of defense: their eyes are not placed in the front of the head as in beasts of prey, but on the side of the head, very prominent, so that they are enabled to see before, behind, and all around them; their ears also can be turned this way or that way to catch the slightest sound, added to which, they have a degree of timidity which keeps them always on the alert.

With regard to their sense of pain, it is well to know that a hare never, or very seldom, cries out when shot, even if she receives her death-wound, if she can run a few yards and hide herself; but if her legs are broken, or she is in any way stopped from running, even if caught in a net, which can give her no real pain, she utters most piteous screams; when followed by dogs, her screams always begin before they have actually caught her, and it is worthy of notice that she is much more readily dispatched than perhaps any other animal of her size.

Rabbits resemble hares in this respect, as they utter no cry when wounded, but will do so from fear; if run down by a stoat

or weasel, they always cry out when the enemy gets within two or three yards of them, and are generally so terrified that they lie down and are caught; therefore the cry in this case is evidently from fear.

I one day disturbed a rabbit which ran away in so singular a manner that I followed it, and saw that the flesh had been eaten away from the back of the head to the top of the shoulders; the sight was so sickening, that I turned away, thinking the poor creature could not live many minutes. About two hours afterwards, I went with a view to pick up and examine the rabbit, and when I came to the spot, was surprised to see it jump up and run away as before; the person who was with me ran after it, the rabbit ran into a bush and he caught it. Now, although the poor thing was so injured, there was no cry when I first disturbed and ran after it, or when it was disturbed and followed the second time, but the moment it was caught it began to cry out, showing that fear could excite a cry which all its sufferings could not do.

When rabbits are caught in traps, if not taken out in a short time they are almost sure to escape, either by breaking away by force from the trap, and tearing off the leg, or by biting the leg off. These traps are made to clasp very strongly, but to prevent escape as far as possible, they are made purposely not to close nearer than about the eighth of an inch, and the teeth are rounded so as not to cut; but rabbits are so indifferent to pain that I have seen their legs left in traps with the sinews attached to them, just as the sinews are drawn from the fowl's legs previous to cooking, and yet although the bone is so broken, and the muscles and sinews torn apart in this manner, it seems to have little or no effect on the health of the animal.

I have seen them caught after having recently lost a leg, and to all appearance, in as good health, and as fat, as if nothing had happened to them. A short time since, I saw a rabbit caught which had but one leg, having lost one hind-leg apparently some time, and the two fore-legs very recently, but although the poor animal had been obliged to go along as it could with its one leg and the bare stumps of the others, it was in good condition and healthy.

Rats will bite off their legs in a similar way, and escape; but I do not know of any animal which is strictly a beast of prey, or rather a hunting animal, that will do so. I have never known a cat, polecat, or such animals do it, although they may sometimes lose a leg in a common trap which shuts close and is apt to cut; and I have lately known a fox found in a wood in a dying state, from starvation, with a trap on its leg, an incumbrance that a rabbit would have been free from in a very short time.

These facts, will, I believe, bear me out on the point, that the sense of pain is for the preservation of animals, by compelling

them to take due care of themselves, and that no animal has a greater share of the sense of pain than is necessary for the preservation of the class to which it belongs. The loss of a leg must be a great inconvenience to any quadruped, but rabbits or rats may still procure food without it; even the case before alluded to of the hyena, does not tell against it, as the hyena does not get its food by swiftness of foot alone, nor is its foot the weapon of attack, as with the cat tribe; but if a fox, wild-cat, polecat, or any animal of that description, loses its leg, it is a great chance if it does not die of starvation, unless its prey be very plentiful; therefore, as the legs are of so much importance to these animals, they seem to be endowed with a sense of pain in proportion to their usefulness, as a guard for their preservation.

From the ease and indifference with which crabs and lobsters will throw off their claws, when under the influence of sudden fright, or when their claws are injured, it is evident that their sense of pain from mutilation must be very little; and, according to the argument I have advanced, it may be asked, of what use can the sense of pain be to any of the crustaceous tribes? They are coated in armor sufficient to protect them from all minor enemies, and if they get into the power of an enemy strong enough to crush through their shells, of what use can the sense of pain be to them then? But they shew signs of great pain when thrown into boiling water, and I see no reason why they may not be insensible to pain from mutilations, and yet be sensible, in a high degree, to pain from extreme changes of temperature; for, as there are no bounds to prevent their ranging over all parts of the sea, it is probable that a sense of temperature is necessary to them, and many other animals also, to keep them to those parts of the world which they are formed to inhabit. It may also be useful to keep them to those parts and depths in the sea that are necessary for their young to arrive at maturity.

From the observation of Sir Humphry Davy, and others well acquainted with the habits of fish, it is very probable that the sense of pain in many of them is very trifling; and when we consider the fecundity of the cod, and many other fishes, the number of eggs deposited by a single cod-fish in one season (according to Leuenhœck, upwards of nine millions), and bear in mind, that unless these fish more than double their numbers annually, that of the myriads of fishes that are hatched from these eggs, not more than three or four, on an average, can arrive at the same maturity as the parent fish, the others being all destroyed at different stages of their growth, being the food of other animals; it does seem probable that there is a similar dispensation of mercy to them, as I have endeavored to shew there is to rabbits and hares.

Many cases may be brought forward to shew the absence of pain in insects. I have seen a wasp eat a fly almost immediately after a portion of its own abdomen had been cut off; I have also seen a cockchafer crawling and eating on a hedge after its abdomen had been emptied of the viscera, probably by some bird. It is well known that a dragon-fly will eat freely for a considerable time while confined by a pin through its body; and every one who has collected entomological specimens, must know the difficulty in killing some of the larger moths. But as this paper is already much longer than I originally intended, I shall say no more on this point, as the remarks on the subject in the introduction to Kirby and Spence's Entomology are very generally known.

It may be well to reflect for a moment on the constant slaughter that is going on among the lower class of animals. The number of flies eaten by a single pair of swallows and their young must be immense.

I once observed a rather extraordinary illustration of the law of nature to eat and be eaten. I kept in a glass globe a variety of the smaller aquatic animals, such as the larvæ of the dragon-fly, &c., and one day introduced among them a few of the common water newts and water beetles, one of which was the Dytiscus marginalis. The dragon-flies had been living upon the animalculæ, &c., the newts attacked and devoured the dragon-flies. The next morning I found one of the newts lying at the bottom of the vessel half-eaten, and, while looking on, saw the ditiscus attack another newt. Not wishing to have them all destroyed, I took the ditiscus out of the water, and put it in the sunshine a few minutes, when it flew away, and had not gone more than thirty or forty yards when a sparrow flew after and caught it. This constant destruction of life would be fearful to contemplate, if there is truth in the quotation so often made, that "the poor beetle that we tread upon, in corporal sufferance finds a pang as great as when a giant dies."

April 19, 1847.

ART. X.—*On the Absorption of Carbonic Acid Gas by Liquids;* by Prof. W. B. ROGERS, and Prof. R. E. ROGERS, University of Virginia.

SINCE the experiments of Dalton and Henry of Manchester, and the more elaborate researches of Saussure on the absorption of carbonic acid and other gases by various liquids and solids, this branch of enquiry seems to have been regarded by chemists as in a great degree exhausted, and unlike most of the researches of that earlier day, has failed to command any extensive re-investigation.

The experiments forming the subject of the present paper, extend over a part only of the ground occupied by those of Saussure, but although confined to the absorption of carbonic acid, they embrace many liquids not referred to in his enquiries, or in the similar but less varied observations of Dr. Henry. We believe that they furnish much more accurate results than the simple but rather rude methods used by these experimenters could be expected to afford. Besides a great number of results obtained with different liquids and solutions at 60°, they include in the case of water a series of determinations at *various stages of temperature*, from 32° to 100°.

Apart from the general value which in a scientific sense must always attach to the determination of exact numerical constants in subjects of this kind, there are points of the present enquiry which claim attention from their bearing upon certain other branches of research. It will be seen, for example, in the sequel, that the absorption of carbonic acid gas by sulphuric acid at ordinary temperatures, is far greater than chemists have hitherto suspected, and that the processes in which this gas, before being estimated, is made to pass through or over a considerable volume of sulphuric acid, may lead to errors which although hitherto unnoticed, are too important to be overlooked.

In a paper, *on the analysis of the carbonates*, published in the American Journal of Science in 1844, we called attention to the fact, that in using sulphuric or hydrochloric acid for decomposing the carbonates, the resulting solution or mixture always retains an amount of carbonic acid too great to be neglected in accurate research, and that this gas cannot be expelled without the use of *a continued boiling heat.* Some experiments undertaken in the hope of ascertaining precisely the absorbent power of these acids and solutions, led us into the more extensive field of enquiry, of which we propose now to embody the results.

Availing ourselves, at first, of the simple methods employed by Dalton, Henry and Saussure, we found that with all care in the manipulation and in applying the proper corrections, we were unable to attain consistent and reliable results.

In operating with a graduated tube over mercury, as was practised by Dalton, and by Saussure for the more absorbent liquids, the great slowness of the absorption in many cases, rendered it impossible to determine, even after some days, whether the action was still in progress or had ceased, and the form of the apparatus made it unsafe and almost impracticable to apply that *brisk and continued agitation*, which is the only means of greatly expediting the absorption. With some liquids, such as sulphuric acid, the penetration of the gas is so extremely slow, that without this mechanical aid, weeks of exposure would probably be necessary to complete the absorption. Yet by continued and thorough

shaking for thirty minutes, this result is attained so perfectly, that no prolonged exposure afterwards indicates a continuance of the absorption. The importance of attending to this point in constructing an apparatus for experiments in absorption, is evident from the fact that while by our observation, which occupied generally less than thirty minutes, sulphuric acid of common density was found to absorb 98 per cent. of its volume of the gas, Saussure's experiments, which continued for one or more days, make the absorption only 45 per cent.

The difficulty and uncertainty of the method above mentioned, is moreover increased by the necessity of restoring the instrument to the standard temperature before measuring the absorption, and of taking account of the change of barometric pressure in the interval. To these objections must be added the errors of measurement due to the weight of the column of liquid above the mercury, as well as the large diameter of the tube in which it was necessary to operate, and lastly, the consideration that this method is inadmissible where we are operating with liquids, which like nitric acid and many saline solutions react with mercury.

Results as little satisfactory attended our trials with the other process of Saussure. In this mode of operating, which he adopted in cases where the absorption was small, the liquid and gas are brought together in a well stopped bottle, and after continued agitation for some time, the absorption is measured by removing the stopper in an immersed position. But here, besides the difficulty of making the absorption in a precise manner, we encounter a more serious objection in the fact, that the rarefaction of the remaining gas causes the absorption to cease before reaching the full amount proper to an undiminished pressure. This evil may, it is true, be rendered insignificant in cases where the absorption is slight, by using as Saussure did, a volume of gas many times greater than that of the liquid; but with carbonic acid, such a procedure would in most cases call for so large a volume of gas as greatly to increase the errors arising from a slight variation of temperature during the experiment, while it would augment the difficulty of securing the coincidence of temperature required.

In the syphon formed apparatus used by Dr. Henry, the flexible tube beneath, facilitates the experiment by enabling the operator to apply agitation to the wider limb containing the gas and liquid, but the results are exposed to error from the dilation of the flexible connection and from the effects of concussive compression caused by shaking a large mass of mercury with the gas and absorbent liquid. Of course, this method is inapplicable where the liquid reacts upon the mercury.

From what has now been stated, it will we think be apparent that the modes of experimenting on this subject, used by the dis-

tinguished chemists referred to, were not adapted to an accurate determination of the absorbent power of liquids. To be capable of precise results, the absorbing apparatus must fulfill the following conditions:—

First. It must provide means for maintaining the temperature uniform throughout the experiment.

Second. It must maintain the tension of the gas unaltered.

Third. It must afford means for rapid and continuous agitation of the liquid with the gas.

Fourth. The tube in which the absorption is measured by the mercurial column, must be apart from the vessel in which the absorption occurs, and the mercury must not be introduced into that vessel.

In view of these requisites we were led, after many unsatisfactory trials with other arrangements, to the form of apparatus represented in the accompanying diagram, (see next page,) which, besides greatly expediting the experiments, affords uniform and consistent results seldom varying in successive trials, to the extent of one per cent., and which is equally applicable to all liquids.

Absorption Apparatus.—This consists of a gasometer A, plunged in a large wooden reservoir B, containing water to the level indicated in the figure, adjoining which is a smaller but taller reservoir C, of glass, also containing water. In the latter is immersed, in a fixed vertical position from the strong frame above, a syphon-shaped measuring tube with a finely graduated scale between the limbs. A horizontal arm of thick barometer tube extending from the top of this, is united by a short gum-elastic joint, with a similar tube which bends down over the edge of the frame and is inserted below into the actual opening of the absorption flask D. Cylinder thermometers graduated to tenths of a degree are placed in the gasometer, large and small reservoir, and flask. [Figure 2 is a larger view of the flask.]

The main reservoir, charged as indicated in the figure, contains five thousand six hundred cubic inches of water, the smaller one, of glass, six hundred cubic inches, and the gasometer three hundred cubic inches. The large volume of water in the reservoirs, serves to maintain an almost absolute uniformity of temperature in the flask and measuring tube during the experiment. The capacity of the flask usually employed by us, is 6·2 cubic inches. The measuring tube is read to $\frac{1}{200}$th of a cubic inch.

A long winding leaden tube serves to conduct the gas from the gasometer to the flask in the process of charging the latter, and being plunged in the water of the large reservoir, secures us against any variation of temperature in the gas, which might arise from the reaction of the materials in the gasometer. The gas will thus in all cases have the temperature of the main res-

Fig. 2.

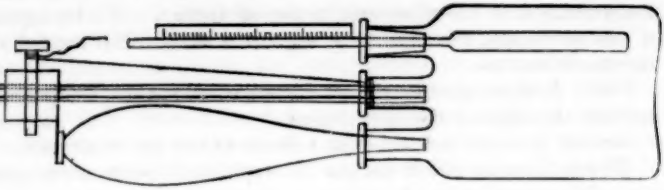
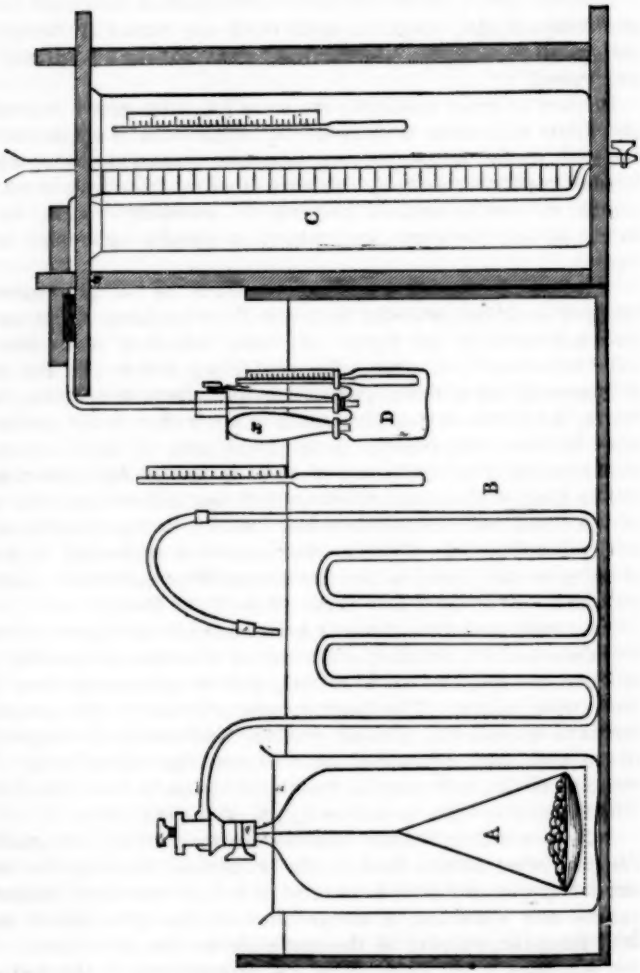


Fig. 1.



ervoir, when conveyed into the flask. The end of this tube is mounted with a close cork and smaller glass tube, to be placed in the near opening of the flask when the gas is to be passed into the latter and the measuring tube.

Connected with the flask is a movable vessel *x*, adapted by accurate grinding to the mouth of the former, and designed to contain the liquid whose absorbent power is to be determined. This *unit bottle* as we will call it, has its opening below contracted to about *one-eighth of an inch*, so that when filled with the liquid and connected in an inverted position with the flask, as in the diagram, *the liquid is in no danger of flowing out.* When thus inserted in its proper position, it is confined in place by the strong pressure of a steel spring, attached to the central tube of the flask, and which by a revolving motion is then brought to press by a leather cushion upon its upper end. This secures the juncture at the stopper perfectly air-tight during the active agitation of the flask.

The central tube is in like manner ground to an air-tight joint at its insertion into the flask, and the connection is forcibly secured by a strong cord wrapped around the neck and then passed around a screw peg inserted in a wooden block which is firmly cemented to the tube above. To avoid all chance of leakage at this and the junction of the unit bottle with the flask, a very delicate coating of tenacious cement made of beeswax, rosin and tallow, is applied to the upper part of the ground surface. This from its very minute amount, and its removal from the gas in the interior, is incapable of exercising any appreciable absorbent effect. Indeed we have found that even with a large mass of this cement placed in the flask, the effect is quite insignificant.

The flask suspended by the horizontal part of the tube just described, hangs, when in its natural vertical position, at such depth as to immerse about half the length of the unit bottle. The agitation is given by a hooked rod which embracing the central neck, is moved to and fro longitudinally, and causes the flask to swing as rapidly as the operator pleases, the axis of motion being the part of the horizontal tube which is external to the flexible joint, and lies upon the wooden frame near its end. The rest of the horizontal tube is connected with the measuring tube, and firmly attached, along with the latter, to the horizontal bar of the frame. This slides up and down upon the vertical supports, and can be adjusted to a proper position by the movable pins seen in the figure, immediately beneath it, or can be lifted off, carrying the measuring tube and flask. To secure the axis tube from lateral motion during the shaking, a wooden block descends by a hinge over the flexible joint and this tube, and embracing them in a longitudinal groove retains them in place.

The stop-cock at the bottom of the measuring tube is used for adjusting the level of the mercury in the two limbs at the beginning of each experiment, and for removing the mercury which is poured in through the funnel above, to maintain the columns at the same height during the progress of the absorption.

It will be seen from the figure, that while the flask and measuring tube are both constantly immersed as the experiment is going on, and are thus kept at an invariable temperature, the connecting tube, between the two levels of water, is necessarily out of the liquid, and must be influenced by the temperature of the ambient air. The capacity of this exposed part of the tube was found to be very nearly $\frac{2}{10}$ths of a cubic inch, the expansion of which for 1° is equal to $\frac{1}{2000}$ cubic inch. As the temperature of the apartment seldom differed from that of the apparatus by more than some four or five degrees during our experiments, the entire error would be within $\frac{1}{2000}$th of an inch, while as before mentioned, the smallest reliable reading of the measuring scale is $\frac{1}{2000}$th cubic inch. It has therefore been thought useless to attempt any correction for the temperature of this part of the enclosed gas.

Mode of Manipulating.—From the description just given of the several parts of the apparatus, the general method of operating with it will be readily inferred, and but few words need be added on this head.

Bringing the entire apparatus to the required temperature, (60° in most of our experiments,) the unit bottle, charged with the liquid to be used, is hung in the large reservoir, to attain exactly the same temperature. The back of the gasometer pipe is inserted in the flask air-tight, and a brisk stream of carbonic acid is suffered to flow through the apparatus for five minutes. Some mercury is now poured by a long funnel into the measuring tube to arrest the current. The flask being raised so as to lay bare the mouth, the cork is withdrawn, and at the same moment, while the stream of gas is pouring out and overflowing from the flask, the unit bottle is secured in the opening and fastened by the spring above. After swinging the flask down to its vertical position, the level of the mercury in the measuring tube is carefully adjusted, and the agitation is now commenced. The liquid at first descends only by drops, but soon begins to flow more rapidly. The vibratory movement of the flask is of that sudden kind which effectually brings the gas and liquid into intricate contact—and the absorption rapidly proceeds. Two operators are necessary in conducting the experiment, one to keep up the shaking, and the other to supply the outer limb of the measuring tube with mercury as the column on the other side ascends.

With water, we have found the absorption to be completed in about five minutes. The oils, dense saline solutions and sul-

phuric acid, require a longer time, but even with the last named substance which is one of the most sluggish in its action, the absorption reaches its limit in less than thirty minutes.

Purity of the Carbonic Acid.—The gas used in our experiments was supplied by the reaction of dilute hydrochloric acid and fragments of calc spar, contained in the self-regulating apparatus figured in the preceding diagram. For sometime, after charging the vessel with water and acid, the gas evolved contains a marked proportion of atmospheric air, derived from the air originally present in the water, and which is slowly disengaged as the carbonic acid is absorbed by the liquid. This admixture with air was found to continue until the solution became well charged with the gas, and this result, in the ordinary use of the apparatus, was very slowly attained. To hasten the saturation, and thus bring the materials into a condition to furnish unmixed gas, the action of the acid liquid on the carbonate was renewed at short intervals, by opening the stop-cock of the reservoir, and in this way in a few hours the gas evolved was almost absolutely exempt from atmospheric air.

At the commencement of each set of experiments, a specimen of the gas, two cubic inches, was passed into a tube over mercury and tested by a moist fragment of caustic potash. When the contents of the reservoir were in a proper condition, the residuum of unabsorbed gas in this experiment was a *mere globule*, rarely more than $\frac{1}{25}$th of an inch in diameter, and therefore indicating from $\frac{1}{1250}$th to $\frac{1}{2500}$th of gaseous impurity.

Thus assured of the almost total absence of atmospheric air in the gas supplied under these conditions, our next precaution was to determine the degree of purity it retained, when transferred, as in our experiments, by simple displacement into the flask and measuring tube. For this purpose a V shaped tube, eighteen inches in each leg, with a stop-cock at the bend, was attached temporarily to a flask like that of the absorbing apparatus, and was charged by allowing a stream of CO_2 to pass through the vessel and tube steadily for five minutes. The stop-cock of the tube was then closed, the open end stopped with the finger, and the tube detached and inverted over mercury. The contents were now examined in the usual way with caustic potassa. In a number of such trials, made at different stages of our investigation, we found the amount of residual gas to range from about $\frac{1}{4000}$th to $\frac{1}{2000}$th of the entire volume employed. In the absorption apparatus, the charge of gas is probably less, and certainly not more contaminated with atmospheric air than in the trials just mentioned, and can therefore involve no sensible error from this source.

It remains to ascertain how far the CO_2, escaping from the gasometer, might be mingled with *hydrochloric acid*. The pres-

ence of this impurity was deemed so probable, that in our first experiments, a small vessel containing nitrate of silver was interposed in the current of issuing gas. Finding no milkiness to arise in the time required for the experiment, we prolonged the trial to a period of several hours, during which a stream of gas from the gasometer was passed in bubbles through the nitrate. But no precipitate was formed. This result, many times repeated, sufficiently attests the absence of *hydrochloric acid from the gas.* It is important, however, to remark, that using a *much larger proportion* of hydrochloric acid with the water of the reservoir, distinct traces of this substance may be detected in the issuing gas, and to remove all chance of error, therefore, after each new charge of acid, the gas was carefully tested by transmission through the solution of nitrate of silver.

Of the Hygrometric State of the Gas.—Excepting in the experiments on sulphuric and some other acids, the gas was transmitted through the long submerged tube into the flask, *without desiccation.* This course was rendered necessary by the fact, that in repeated trials, with gas previously dried and saline solutions, there occurred an irregular expansion of the gaseous volume in the first stage of the action, which did not show itself when the undried gas was used. Such an enlargement, due evidently to the rise of aqueous vapor into the dry space in the first moments of the agitation, being of variable amount according to the solution used, would form a serious obstacle to the exact measurement of the absorption.

In the case of the sulphuric acid and other bodies referred to as exceptions, this would not take place. On the contrary, the *presence* of aqueous vapor in the gas would here involve other errors, due to the absorption of the vapor by the liquid, or to the heat disengaged by their reaction.

The drying of the gas being thus prohibited in a great majority of the experiments, it became important to ascertain whether the carbonic acid, coming from the gasometer, was *saturated* with vapor, as in this case, from the *observed absorption of the moist gas*, it would be easy to compute the *amount of dry gas* which had actually disappeared.

For this purpose, the acid solution in the gasometer was allowed to continue its action until it became *entirely neutral.* A measured volume of the gas was then passed *very slowly* through a long drying tube of chlorid of calcium, previously counterpoised. By preliminary trials with an additional smaller tube, similarly charged, it was ascertained that scarcely a trace of moisture escaped absorption in the long tube. Before the second weighing of the latter, it was freed from carbonic acid by aspiration, the smaller tube being attached to prevent the entrance of atmospheric moisture. In repeated experiments thus performed, the

weight of vapor contained in the gas was found to correspond closely with that proper to the temperature and a state of saturation. In other words, *the vapor mingled with the gas was at its maximum tension.* As in its neutral state, the liquid of the gasometer contained most dissolved matter, it was to be inferred that the effect upon the tension of the vapor rising from it would then be most perceptible, and that therefore in the working condition of the apparatus, the saturation of the vapor could not be less, although it might be a small fraction more. Similar experiments with the gas under these conditions gave us, however, the same results. We concluded, therefore, that the dissolved matter in the gasometer, is not in sufficient quantity to produce a sensible modification of the tension of the aqueous vapor evolved, and that in all our experiments, *we may assume the gas to be saturated with vapor proper to the temperature at which we operate.*

Of the Correction for Moisture.—This being deduced from the pressure of the atmosphere and the vaporous tension jointly, requires a record of the barometer for each experiment. By the equal adjustment of the columns in the measuring tube, the entire tension of vapor and gas together, is the same at the close as at the beginning of the experiment, and is measured by the height of the barometer. The tension of the vapor remains unchanged, because it is vapor of saturation, and is condensed into water in proportion as the gaseous space contracts in the progress of the absorption. If therefore V represent the *apparent absorption*, or the volume which has disappeared, and v the volume of dry gas in V, estimated under the full atmospheric pressure; and if p denote that pressure, in other words, the height of the barometer, and f the tension of the vapor proper to the temperature, we have $v = \mathrm{V} \cdot \frac{p-f}{p}$.

It is important to remark, that the tension of the gas under which this absorption takes place, is $p-f$, and not p, and that in tabulating the results, the corrected absorption should refer to *the actual pressure of the gaseous atmosphere* in the flask, and not to the entire atmospheric pressure.

From experiments upon the absorption of carbonic acid gas at *various pressures* by water, Dr. Henry, as is well known, was led to infer that equal volumes are absorbed at all pressures, or what is the same thing, that the quantities of gas absorbed are exactly proportioned to the pressures. This very simple law, if true, would render the correction for moisture superfluous. For in that case, the volume absorbed at the pressure $p-f$, would equal the volume absorbed at p. Thus V, the *apparent absorption*, that is, the volume disappearing at the pressure p, consisting partly of gas and partly of vapor, would be precisely the same as the volume of dry gas alone which would disappear at the same

pressure. But further experiments are, we think, needed, to determine with precision the law of absorption as dependent on pressure, and in the mean time, the law of Henry can only be looked upon as approximately true. From observations on this subject in which we have lately been engaged, and which we hope to continue, we have been led to infer that, in comparing widely variant pressures, there is a marked departure from this law.

Although therefore, from the small difference of gaseous pressure (that between p and $p-f$) in our experiments, we believe that no sensible error could be introduced by applying the law of Dr. Henry to the results, we have thought it proper in reporting them, to state the volume of dry gas absorbed and the reduced pressure, as well as the apparent absorption and entire barometric pressure.

Having now presented all the details of our mode of operating, and of the precautions and corrections we have used, we proceed to give an account of the results, treating of them in the following order:

I. Of the absorption by water.

II. Of that by sulphuric and other acids, and by other unmixed liquids.

III. Of that by various saline aqueous solutions.

I. *Absorption of Carbonic Acid by Water.*—The water used in these experiments, as well as in making the solutions employed in others to be described hereafter, was prepared by careful distillation in a copper vessel. Its purity was such, that several cubic inches evaporated in a platinum capsule, gave no indication of alkaline matter to the most delicate test paper, and when entirely volatilized, left scarcely a trace of residuum. Before being used, it was briskly boiled for half an hour, quickly transferred to a well stopped bottle, and when sufficiently cooled, exposed to the exhausting action of a good air-pump. The bottle was then suspended in the large reservoir, to bring it to the proper temperature, before the charge was introduced into the flask.

The absorption was seen to begin as soon as the first drop descended from the flask, and with brisk agitation, the process was completed in about five minutes after the liquid was brought in contact with the gas. To satisfy ourselves that no further absorption would occur, we repeatedly prolonged the agitation to fifteen or twenty minutes, allowed the apparatus to rest, and again resumed the shaking, but without producing any appreciable change in the column of the measuring tube.

Although, from the purity of the gas used, the closeness of the apparatus, and the care with which it was charged with gas, we had no reason to apprehend *any dilution* of the CO_2, yet as such a change would cause the absorption to terminate short of the saturation of the liquid proper to an unmixed atmosphere of the

gas, experiments were made to determine if any further absorption was caused by a renewal of the charge. This was done by removing the flask, driving a stream of CO_2 into the bottle, closing the orifice by an air-tight stopper, readjusting the levels, and submitting the liquid to further agitation. Repeated trials at 60°, gave no indications of additional absorption. We would therefore regard our results as furnishing a nearly accurate measure of the absorption of carbonic acid by pure water.

These results, together with the conditions under which the observations were made, are comprised in the following table.

Table of the Absorption of Carbonic Acid by Water, from 32° to 212°.

No. of Ex.	Temp. of CO_2 & HO.	External thermometer.	Barom. $=p$.	App. abs. by 100....HO.	Mean of app. abs. $=V$.	Mean abs. of dry CO_2 $=v$.	Tension of gas $=p-f$.	Abs. V reduced to 60°.
1	32°	54°	29·48	166·				
2	32	54	29·48	166·5	166·25	165 08	29·28	175·72
3	40	55	29·46	142·5				
4	40	55	29·46	142·	142·25	140·8	29·21	147·94
5	50	55·5	29·46	119·5				
6	50	55·5	29 46	120·5	120·	118·44	29·1	122·27
7	60	64·5	29·42	100·5				
8	60	64·5	29·42	100·2				
9	60	64 5	29·42	100·5	100·4			
10	60	65	29·25	100·5				
11	60	65	29·25	100 8	. .	98 5	28·82	100·5
12	60	65	29·25	100·5				
13	60	65	29·25	100·5	100·6			
14	70	72	29·21	85·5				
15	70	72	29·21	85·5	85·5	83·36	28·48	83·86
16	80	75	29·51	71·				
17	80	75	29·51	71·5	71·25	68·75	28·5	68·60
18	90	80·5	29·54	60·5				
19	90	80·5	29·54	61·2	60·85	57·78	28·18	57·50
20	100	80 5	29·54	54·5				
21	100	80·5	29·54	54·	54·25	49·83	27·68	50·39

On comparing the second and third columns in the above table, it will be seen that, in the observations from 50° to 80° inclusive, the temperature of the contiguous air in no case differed from that of the apparatus by more than 5°·5. Hence during the few minutes occupied in each experiment, the temperature even of the smaller reservoir experienced only a very slight and quite unimportant change, amounting in none of the experiments to as much as *one-tenth* of a degree. In the experiments at 40°, it was found easy to maintain a uniform temperature by a few fragments of floating ice, and in those at 32°, the use of a large amount of ice in both vessels, preserved the temperature entirely unchanged. The observations at 90° and 100°, were attended with a slight cooling in the small reservoir, which however, in no case exceeded one degree, an amount too small to produce any measurable change in the mercurial column.

The above table presents we believe the first systematic series of observations on the comparative absorption of CO_2, by water at

different temperatures, yet made known. The experiments of Dalton, Henry, Manchester and Saussure, were made almost exclusively at 60°. The only results, referring to other temperatures, which we have seen numerically noted, are one by Cavendish at 55° and one by Henry at 85°. According to Cavendish the absorption by one hundred volumes of water at 55° is one hundred and sixteen. In Henry's experiment the same volume of water at 85°, is said to have absorbed eighty-four volumes of the gas. The latter result departs very widely from the mean of our experiments at 80° and 90°, which is about sixty-six volumes instead of eighty-four. The experiment seems to have been made with little care and merely to test the effect of a higher temperature upon the amount of absorption. The number obtained by Cavendish in his observation at 55°, corresponds more nearly with our results, which, taking the mean of the experiments at 60° and 50°, would be about one hundred and ten, instead of one hundred and sixteen, the number which he has given.

In the more numerous and important experiments at 60°, the observed absorption as given by Saussure, is one hundred and six, by Henry, one hundred and eight, and by Dalton, one hundred. The two former present a marked excess over our result, the latter agrees with it very closely. The larger absorption obtained by Saussure and Henry, is we think explained by their mode of conducting the experiment. We have found that when a column of mercury is shaken briskly in a tube containing water and carbonic acid, the water is made to absorb a larger volume of the gas than is proper to the normal pressure. The concussive movement, violently compresses the gas at each vibration, and the additional quantity which in these circumstances is promptly taken up by the water, is very slow in separating after the quiescent pressure has been restored.

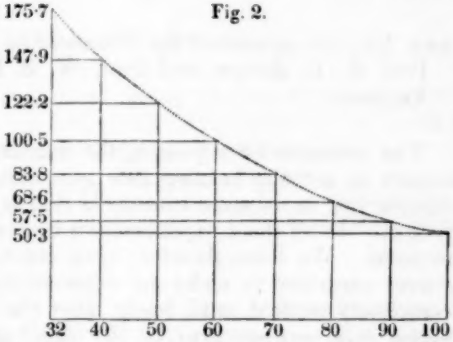
Referring to the arrangement of the preceding table, it will be seen that the numbers in the 7th column express the absorption, reduced to volumes of dry gas and to the density corresponding to p in the 4th column. The obvious formula for this has already been explained. The numbers in the 8th column represent the actual tension of the gas under which the absorption took place. These two columns give the direct experimental relation of the absorption of dry gas with the tension of the same. But assuming Henry's law to be correct, and in the present case it can involve no sensible error, this relation would be equally expressed by the corresponding numbers in columns 4 and 6. Thus while it is clearly proved, from the observations at 50°, that under the pressure $29{\cdot}1 = p - f$, 118·4 volumes of dry gas are absorbed, it would also be true that under the pressure $29{\cdot}46 = p$, 120 volumes of dry gas would be absorbed, for $p : V = p - f : v$.

It is further evident that admitting this law, all the numbers (p) in the column of barometric heights may be reduced to one standard number, as for example 30 inches, without at all changing the volume of V. Thus at 50° while one hundred and twenty volumes are absorbed under a pressure of 29·46 inches, one hundred and twenty volumes will also be absorbed at a pressure of 30 inches, the latter volumes being denser than the former in the proportion of 30 to 29·46.

The last column of the table represents the values of V, contained in column 6, after they have been *reduced to the common temperature* 60°. These numbers therefore indicate the relative *quantities or weights* of carbonic acid absorbed at the temperatures recorded.

The relation of the absorption to the temperature is simply pictured in the accompanying diagram, where the temperatures are measured in the horizontal, and the corresponding absorptions in the vertical direction.

Fig. 2.



It will be remarked that this curve approaches the horizontal axis less rapidly, as the temperature rises, so that, for example, the absorption is greatly more diminished in passing from 40° to 60°, than in passing from 60° to 80°, and still more than in passing from 80° to 100°. This would lead to the inference that at temperatures much above 100°, we should find the absorption still quite considerable.

To satisfy ourselves on this point, we made repeated experiments at 150° and 212°, by passing a stream of gas from the pipe of the gasometer through a measured quantity of water, maintained by a peculiar lamp arrangement, at the proposed temperature. The pipe being withdrawn while the temperature was continued, any floating carbonic acid was removed from the surface of the liquid by a blast of air, and a solution of baryta was then added. In the water at 150°, a very copious precipitate was formed. This was separated by filtration under a vessel kept full of hydrogen gas to prevent the absorption of atmospheric carbonic acid by the precipitant, and the weight of the carbonate determined by the method of double filters.

By this procedure, 14·5 cubic inches of water at 150°, gave 3·51 grs. of carbonate of baryta, which corresponds to 11·4 *volumes of carbonic acid gas for one hundred volumes of liquid.*

In the water at 212°, a precipitate was also formed, but the amount although sufficient to produce a very obvious cloudiness, was too small to be readily estimated. We propose however to determine its quantity accurately hereafter. In this experiment the liquid was in active ebullition, while the stream of gas was passing, and continued to boil for a few seconds after the removal of the gas pipe.

It is thus clearly proved that water is capable of absorbing carbonic acid, in sensible quantity, while it is actually boiling under ordinary pressure.

(To be continued.)

ART. XI.—*Oxydation of the Diamond in the Liquid Way;* by Prof. R. E. ROGERS and Prof. W. B. ROGERS, University of Virginia.

THE processes for oxydating the diamond, hitherto described, consist in actually burning this gem either in the open air, in oxygen gas, or in some substances rich in oxygen, as nitrate of potassa. In all these experiments a very elevated temperature is required. We have therefore been much interested by the discovery suggested to us by our experiments on graphite, but not completely verified until lately, *that the diamond may be converted into carbonic acid in the liquid way and at a moderate heat, by the reaction of a mixture of bichromate of potassa and sulphuric acid,* in other words, *by the oxydating power of chromic acid.*

The method of proceeding is much the same as in the oxydation of graphite, as described by us in the May number of this Journal; but the progress of the action is slower.

To succeed in the experiment, it is necessary to reduce the chips of diamond to *a very fine powder*, by trituration with repeated portions of pure siliceous sand in an agate mortar. A single grain weight of the gem will suffice for several experiments. In our repeated trials we have generally used less than half a grain, and we have obtained unequivocal proof of oxydation, by the evolved carbonic acid, when using less than $\frac{3}{10}$ths of a grain.

The apparatus employed, is in the main, identical with that used in the analysis of graphite, but the Liebig tube is in this case replaced by a vessel containing lime water.

Precautions are necessary to correct a slight error arising from the evolution of a minute amount of carbonic acid from the bichromate and sulphuric acid, caused by the presence of a trace of organic matter or of carbonate in the former.

Operating on half a grain of diamond, we have in a first process obtained half a grain of carbonate of lime, and using the residuary matter have continued the oxydation, until at length the amount of carbonic acid evolved approached nearly to that due to the entire weight of the diamond. In these experiments, the carbonic acid evolved by the bichromate and sulphuric acid is first expelled from the apparatus, by a particular mode of conducting the operation.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Researches on the Latent and Specific Heat of Bodies;* by C. C. Person, (Compt. Rendus, t. xxiii, p. 162; Pogg. Annalen, lxx, p. 300.) —Person gives the following as his results on latent heat :—

Substances.	Melting point.	Latent heat for unit of weight.
Tin, ...	235° Cent.	14·3
Bismuth, ...	270 "	12·4
Lead, ...	320 "	5·15
Zinc, ...	423 "	27·46
D'Arcet's alloy$_2$, Pb Sm$_2$ Bi$_3$, .	96 "	5·96
Fusible alloy, Pb Sn$_2$ Bi, . .	145 "	7·63
Phosphorus, ...	44·2 "	4·71
Sulphur, ...	115 "	9·175
Nitrate of soda, ...	310·5 "	62·98
Nitrate of potash, ...	339 "	46·18
Phosphate of soda, PO$_5$ 2Na O24HO,	364 "	54·65
Chlorid of calcium, Cl Cao+6Ho, .	28·5 "	45·79
Yellow bees' wax, ...	62·0 "	43·51

If we examine this and the following table, we see that the latent heats do not follow the order of the temperature, and that they are not, also, inversely as the atomic weights, as was supposed. But they are related to the fusing points and specific heats as

$$(160+t)\delta=l,$$

where t is the fusing point, l the latent heat, and δ the difference between the specific heats in the solid and liquid form. This relation may be expressed by the following proposition :—*To obtain the latent heat, the difference between the two specific heats must be multiplied by the number of degrees between* – 160° *Cent. and the melting point.* The latent heats calculated by this formula agree pretty well with those observed.

The following are his results on specific heat :—

Substances.	Temperatures between which the specific heat was observed.	Specific heat.
Tin, ...	340° and 240° Cent.	0·061
Bismuth, ...	370 " 280 "	0·035
Lead, ...	440 " 340 "	0·039
D'Arcet's alloy, $PbSn_2B_3$,	300 " 136 "	0·036
do. . . .	136 " 107 "	0·047
do. . . .	80 " 14 "	0·060
do. . . .	50 " 12 "	0·049
Fusible alloy, $PbSn_2Bi$,	330 " 143 "	0·046
Phosphorus, . . .	100 " 50 "	0·212
Sulphur, . . .	147 " 120 "	0·235
Nitrate of soda, . .	430 " 330 "	0·413
Nitrate of potash, . .	435 " 350 "	0·344
Phosphate of soda, .	79 " 44 "	0·758
do. . . .	2 " –20 "	0·454
Chlorid of calcium, .	127 " 100 "	0·519
do. . . .	100 " 60 "	0·628
do. . . .	60 " 31 "	0·358
do. . . .	28 " 4 "	0·647
do. . . .	2 " –20 "	0·406
Yellow bees' wax, .	102 " 66 "	0·54
do. . . .	58 " 42 "	0·72
do. . . .	42 " 26 "	0·79
do. . . .	26 " 6 "	0·52
do. . . .	2 " –20 "	0·39
Ice, ...	0 " –30 "	0·505

This table of the specific heats shews that they are nearly the same in the solid and liquid form for metals. The differences belong to the classes of those produced by change of temperature, and not by a change of the state of aggregation. This equality appears at first sight to upset his formula; but in reality it does not do so, if we consider the formula in its physical sense, and not as an empirical one.

2. *Note on the means of testing the comparative value of Astringent Substances for the purpose of Tanning;* by ROBERT WARINGTON, Esq., (Phil. Mag., xxxi, 150, from the Proceedings of the Chemical Society.)—Having been frequently called upon to examine the value of astringent substances imported into this country for the purposes of tanning, such as valonia, divi-divi, sumac, cutch, &c., I am induced to believe that the detail of the manipulation adopted may not be without interest to some of the members of the Society. As the manufacture of leather was the object of the purchaser of these materials, gelatin was selected as the basis for the estimation of their comparative value; and after several trials with various kinds of natural and manufactured gelatin, such as varieties of isinglass, glue, patent gelatin, &c., the finest long staple isinglass was found to be the most constant in its quality and least liable to undergo change.

With this therefore the test solution was prepared, of such a strength, that each division, by measure in the ordinary alkalimeter tube, should be equivalent to the one-tenth or one-fourth of a grain of pure tannin, and thus the number of divisions used would indicate the proportion of available tannin or substance precipitable by gelatin contained in any specimen. A given weight of the sample under trial was then infused in water, or if necessary the astringent matter extracted by boiling, and the clear liquid precipitated by the test solution until no further deposit occurred.

It was necessary in the course of this operation to test at intervals a portion of the solution under examination, to ascertain the progress of the trial; and this, from the nature of the precipitate, was attended at first with some little difficulty: paper filters were inadmissible from the quantity of the solution they would absorb, and thus introduce a source of extensive error; subsidence rendered the operation very tedious. The plan I have adopted is as follows:—a piece of glass tubing, about twelve inches in length and about half an inch internal diameter, is selected, and this has a small piece of wet sponge loosely introduced into its lower extremity, and when it is wished to abstract a part of the fluid under investigation for a separate testing, this is immersed a few seconds in the partially precipitated solution; the clear liquid then filters by ascent through the sponge into the tube, and is to be decanted from its other extremity into a test glass; if on adding a drop of the gelatin solution to this a fresh precipitate is caused, the whole is returned to the original bulk, and the process proceeded in, and so on, until the operation is perfected; this method of operating is facilitated by conducting the examination in a deep glass. After a few trials the manipulation will be found extremely easy, and in this way considerable accuracy may be arrived at.

3. *On the Manufacture of pure Sulphuric Acid;* by Aug. A. Hayes, M.D., Assayer to the State of Massachusetts, (communicated for this Journal.)—In the arts, the rapid extension given to refined operations, has led to the consumption of pure chemical products. Applications of such substances as were formerly only in the hands of accurate chemists, are now of daily occurrence in manufacturing. The want felt for pure sulphuric acid, has to a certain extent been supplied by the Nordhausen acid; but aside from a higher price restricting its consumption, the manufacture is foreign to this country.

Without entering into scientific details, I shall describe an economical process which I have carefully studied and by which the pure acid, used in my laboratory, has long been obtained.

In the manufactories of sulphuric acid, the weaker acid from the lead chambers is concentrated in lead pans, usually to the density of 1·76, and transferred without cooling to the platinum alembics for further concentration.

The modification commences with the hot acid, and it may be supposed to contain sulphurous acid, hydrochloric acid, hyponitric acid, arsenous acid, oxyds of iron and lead, alumina, lime, soda and organic matter, although the acid obtained from the combustion of Sicily sulphur, is rarely thus impure. On adding to the hot acid sufficient nitrate of potash, or soda, to destroy the organic matter, the brown

color disappears and the fluid becomes colorless. The addition of $\frac{1}{300}$ of sulphate of ammonia, removes the remaining hyponitric acid; much of the hydrochloric acid has been removed by the nitrate, and sulphurous and arsenous acids carried to their highest stage of oxydation. The oxyds present, aid the further purification; by continuing the concentration to 1·78, a trifling addition of oxyd of lead is made, but it is essential to the success of the process that this point of density be reached. The fluid must now be cooled in deep vessels of lead, the temperature of it being gradually reduced to 32° F., and allowed to become perfectly clear. The clear part must then be run into shallow lead vessels so placed that they may be refrigerated to 0 Fahr. As the whole acid has nearly the hydrate composition of SO_3+2HO, it would form by repose a solid crystalline mass. In ordinary cases, the regular crystals form solid masses, which are allowed to increase, till one-half the bulk of the fluid has assumed the solid state, when the remaining liquor is rapidly removed, the crystals broken up and washed with some acid resulting from the crystals of a former operation.

When crystallized in this way, nearly all the contamination which can be detected, arises from the fine granular sediment of anhydrous sulphates and arseniates of iron and lead, mixing with the crystals from careless washing. These substances are deposited in the cooling, but more abundantly in the course of the crystallization of this acid. The crystals melted in lead kettles which have been recently washed with ordinary sulphuric acid, afford an acid nearly pure, and if required in the concentrated state, may be transferred directly to the platinum alembic, melted and boiled. For the most delicate researches, the crystals must be melted in glass, or stone-ware, recrystallized out of contact with metals or dust, leaving one-half or one-third of the acid in a fluid state. If the subsequent use of the acid does not require the removal of the water, which is very rarely the case, the crystals being a perfectly definite hydrate when fluid, enable us to weigh and apportion the quantity of real acid with great precision.

In the laboratory, when used for cases of difficult decomposition, it may be added to the crystallized bisulphate of potash, mixed with the substance to be acted on, and the whole brought to any state of dryness in the platinum utensils employed in such operations.

All the acid from which the pure acid has been abstracted, may be used for generating nitric, or hyponitric acid in the manufacture of sulphuric acid. The manufacture may best be carried on during the winter months, and the crystals obtained, stored, or melted.

This hydrate is remarkable for the regularity and great size of its crystals. They are oblique four sided prisms, and often present faces of twelve by sixteen inches. Their capacity for heat is also surprising; small parcels exposed at the mean temperature of 46° F., melt with extreme slowness.

Lowell, Mass., April 28th, 1848.

II. Mineralogy and Geology.

1. *On the Wave of Translation in connexion with the Northern Drift;* by W. Whewell, D.D., F.G.S., (Lon. Quart. Jour. Geo. Soc., Aug. 1847.)—The great geological problem of the "Northern Drift" has been attacked in various ways; and the diffusion of Scandinavian rocks and northern detritus over a vast area in the northern part of Europe has been ascribed to various kinds of natural machinery. Of late, a large part of this operation has been attributed to "Waves of Translation," produced by the sudden upheaval of the bottom or shore of the sea. This view is advocated in the 'Geology of Russia' by Sir Roderick Murchison.* There are some very simple numerical calculations which belong to this subject, and which may throw some light on the probability of such a theory. These calculations must necessarily be hypothetical as to their quantities, but as to their quantities only; and even these will be capable of correction by a more careful survey of the facts. For the mathematical doctrine on which they proceed is rigorously true, and does not depend upon any hypothetical view of the structure of the masses which we have to deal with. Mr. Scott Russell tells us that the wave of translation may be regarded as a mechanical agent for the transmission of power, as complete and perfect as the lever or the inclined plane. Assuming this property of the wave of translation as a basis, I shall point out some of the results of its operation in the case now to be considered.

It has been stated to the Geological Society, that, by supposing the sudden elevation of a submarine district, there is no difficulty in accounting for a current of twenty-five or thirty miles an hour at the bottom of the sea, as a consequence of the "wave of translation." In making this assertion, I think it has not been sufficiently considered that what is thus called a "current," is really a *transient* motion for each point of the bottom of the water. The great wave is *solitary;* the fluid *before* and *behind* it is *at rest;* and the particles move *only while* the wave is passing over them. Therefore the effect of such a wave upon loose materials immersed in the fluid would be only one of two:—*either* it would carry a *single* mass along with it, giving to it its own velocity,—*or* it would give a *transient* motion to a series of masses in succession, as it passed over each, moving each but a small distance. A single wave of translation cannot explain the situation of a long line of masses *each* of which is moved through a *great* distance.

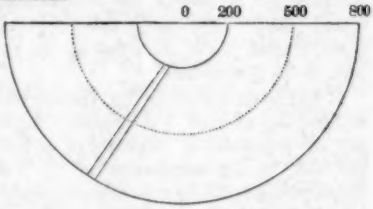
If indeed we suppose a *series* of waves of translation each produced by a sudden elevation, or by some other paroxysmal action, we may obtain a greater effect. In the operation of such a battery, each shock would be transmitted through the water by means of the wave, and would do its measured work; and by accumulating such processes, any amount of result may be mathematically accounted for.

In whatever manner we frame the hypothesis in order to account for the "Northern Drift," the same mathematical equality, between the

* Also at an earlier date in the Memoirs of Profs. W. B. and H. D. Rogers, published in the Trans. Assoc. Amer. Geol. and Nat., 1840–42, and in this Journal.—Eds. Am. Jour.

work done and the force exerted, will hold, as if the effect had been produced by any other mechanical power :—whether the waves be one or many, great or small. And as the amount of the work done in transporting the northern drift from its parent rocks (supposing their place known) to its present position, may be calculated upon assumed numerical bases, we may test the theory of the wave of translation, by thus calculating the amount of sudden elevation which it necessarily supposes. The numbers which I shall assume may be grossly erroneous; but the result being attained, can easily be corrected by changing it in proportion to the alteration which ought to be made in any of the numerical elements.

In the 'Geology of Russia' it is stated that the northern drift occupies a space 2000 miles long and 400 to 800 miles wide. If all the materials were derived from one centre, we might, as a general approximate view, suppose the area to be circular, with a radius of 800 miles; or rather, semicircular, the northern half being for the most part cut off. But if we suppose this semicircle of 1600 miles diameter to be extended to a length of 2000, by taking the *Scandinavian chain* for the source of diffusion instead of a *single centre*, the distance travelled by each mass will be the same as in the supposed circle, which we may therefore make the basis of calculation.



Within the circle of 800 miles radius, I will take an inner circle of 200 miles radius, and I will consider the drift as occupying only the annular space between these two circles.

The *mean* distance from the centre of the annulus lies along a circle of which the radius is 500 miles. I will first consider places at this mean distance.

I must necessarily make some supposition about the mass of the materials which compose the drift. Let it be supposed that, at this mean distance from the centre of diffusion, every square mile, on an average, contains as much drift as would cover it entirely to the depth of one hundredth of a foot. This is equivalent to supposing that there is on each mile, a patch of drift, one-tenth of a mile square and one foot deep; or a ridge or "trainée" of drift, one-tenth of a mile long, one-hundredth of a mile broad, and ten feet deep. It is easy to see that the supposition might be put in innumerable other forms; and by comparing these with many observed facts, some average result might perhaps be obtained.

Supposing this result to be, as I have said, that on every mile there is an average depth of one hundredth of a foot, I shall, for the sake of easy calculation, call this $\frac{1}{500000}$ of a mile (instead of $\frac{1}{528000}$). And thus, on every square mile of ground, at the mean distance from the origin, there is $\frac{1}{500000}$ of a cubic mile of drift.

I will suppose the mean specific gravity of this material to be three times that of water. When the materials are immersed in water, the effective gravity will therefore be twice that of water.

The horizontal force which it requires to move a body along a surface on which it rests, depends on the form of the body, its texture and that of the surface, and other circumstances : but I think we may suppose that it would require a force and pressure of at least one-fourth the weight of the mass moved, to propel rocks and loose materials along the bottom of the sea.

This being assumed, it will require a force (pressure) equal to the weight of half a cubic foot of water to move a cubic foot of drift ; and so, for any other quantities. And to move $\frac{1}{300000}$ of a cubic mile of drift, will require the weight of $\frac{1}{1000000}$ of a mile of water, acting as a pressure.

Now this mass of drift, which is found on an average mile at the mean distance, has travelled 500 miles from the centre. And the laboring force which has carried it through this space, in whatever way it has acted, must be equivalent to the product of the moving pressure and the space through which it has acted ; that is, it must be equivalent to the weight of $\frac{1}{1000000}$ of a mile of water, multiplied into 500 miles.

This is the same as $\frac{1}{2000}$ of a mile of water, multiplied into one mile ; or one mile of water multiplied into $\frac{1}{2000}$ of a mile of elevation.

That is, one cubic mile of water rising through $\frac{1}{2000}$ of a mile (or about $2\frac{1}{4}$ feet) would supply the power necessary to carry the drift which occupies one average mile at the mean distance from the centre of distribution.

Instead of one cubic mile of water, we may take a square of ten miles, $\frac{1}{100}$ of a mile deep ; and this mass rising through $\frac{1}{2000}$ of a mile, will produce the effect now spoken of.

Taking any radius drawn from the centre of the annulus, the part of this radius which lies on the annulus is 600 miles. On each of these 600 miles, we suppose drift to rest. Each portion of drift has travelled a different distance from the centre. But at each different distance from the centre, there may be a different quantity of drift upon the average ; the quantity probably decreasing as we recede from the centre. Let us suppose, for the sake of calculation, that the quantity diminishes exactly *in proportion* as the distance increases ; so that at the distance of 200 and 800 miles, the quantities on a square mile are as four and one respectively.

On this supposition, the laboring force requisite to carry the drift which lies on each square mile of the same radial line, would be the same. It would take the same laboring force to carry $\frac{1}{1000000}$ of a mile through 500 miles (the mean radius), as to carry $\frac{1}{400000}$ through 200 miles to the inner edge of the annular space ; or $\frac{1}{1600000}$ through 800 miles, to the outer edge of the annulus. In each case, the amount of force requisite would be, as before, the weight of $\frac{1}{2000}$ of a mile of water, raised through one mile.

Here the laboring force requisite to carry the drift to the whole of the 600 miles which lie along this radius, would be $\frac{6}{20}$ or $\frac{3}{10}$ of a mile of water raised through one mile ($600 \times \frac{1}{2000} = \frac{6}{20} = \frac{3}{10}$).

Now taking the whole semi-annulus, the length of the mean semi-circle, of which the radius is 500 miles, is about 1500 miles.

Hence if we suppose the radical tracts a mile wide just spoken of to make up the semi-annulus, the force requisite to distribute the whole

mass of drift will be $1500 \times \frac{3}{10}$, or 450 cubic miles of water raised through one mile.

Now though these radial tracks do not make up the annulus, being too broad within the mean distance and too narrow beyond it, this excess and defect balance each other; and therefore we arrive at the conclusion that 450 cubic miles of water raised a mile high would produce an effect equivalent to the dispersion of the whole body of northern drift.

But we may put this result in a shape more readily conceivable. It is equivalent to 4500 cubic miles of water raised through a space of $\frac{1}{10}$ of a mile; or again, to a body of water 45,000 miles in surface and $\frac{1}{10}$ of a mile deep, raised through $\frac{1}{10}$ of a mile. If then we suppose a sea-bottom 450 miles long and 100 miles broad, which is $\frac{1}{10}$ of a mile below the surface of the water, to be raised to the surface by paroxysmal action, we shall have the force which we require for the distribution of the northern drift, on the numerical assumptions which have been made. And this is true, whether we suppose the elevation to have taken place at once, or by repeated operations, so long as they are paroxysmal. We shall have the requisite force, for instance, if we suppose this area to be elevated by ten jerks of 50 feet each, fifty jerks of 10 feet each, or by the same 500 feet any how divided into sudden movements. And as we diminish the area elevated, we must increase the total amount of elevation in the same proportion, so as to retain the same ultimate product of water paroxysmally elevated through a certain space. In all these cases, we shall have a machinery, which, operating through waves of translation, will produce the requisite effect. And if any of our data be held to be erroneous;—the area occupied;—the amount of matter in the drift;—the amount of friction or tenacity to be overcome in propelling it;—the law of its diminution in quantity as we recede from the centre of distribution;—the final result will have to be proportionally diminished or augmented.

It may be asked whether, since the paroxysmal elevation may thus be reduced into successive smaller elevations, the same result would not follow if it were so reduced as to become, not paroxysmal, but gradual, and even insensible: for, it may be said, mechanical power retains its amount however much it be thus distributed through time, and divested of the character of extraordinary violence. And to this I reply, that no action except such as is of a paroxysmal character could produce the effect. This impossibility depends upon the nature of the effect to be produced. The friction of the bottom which supports the drifted materials, and the tenacity of the masses, are to be overcome: and the peculiarity of such resisting forces is this;—that except the force which acts be sufficient to overcome these resistances, it produces no effect, and is altogether lost. If we push at a mass resting on the ground, with a force insufficient to move it, the force which we exert is wasted, and disappears from all calculations which suffer force to be preserved and transferred into the change produced. A very small elevation, even if sudden, would produce a wave of translation which would pass over all the large masses, and leave them unstirred; and the wave would disappear without producing any such effects as we are here endeavoring to account for.

And thus, the great mass of northern drift, inasmuch as no considerable part of its transfer can be accounted for by any minute causes or languid operations of water, is an irresistible evidence of paroxysmal action; and of action in a scale which may be judged of from the conclusion at which we have arrived:—an elevation of 45,000 square miles of sea-bottom through 500 feet. And this conclusion is equally certain, whether or not we suppose the machinery employed in the distribution of this mass from the centre to be waves of translation. For the proposition that the laboring force expended in the transit of this mass of materials must be equal to the force exerted, and that this force must be exerted in such portions as, at every step, to overcome the friction and tenacity of the masses of rock, shingle, and other detritus moved, is equally true, whatever be the machinery employed. As no gradual or minute action could move the masses in question through a yard of space, no accumulation of such action, through any amount of time, could distribute the masses through the great distances which the northern drift has traversed, and spread them over the vast spaces which that formation occupies. The distribution of the northern drift belongs to a period when other causes operated than those which are now in action.

Postscript.—Perhaps it may throw some light upon the subject to remark that a wave of translation differs little from a "debacle" according to the notions of earlier speculators. A wave of translation is a *debacle* conceived according to the more exact notions to which modern science has led. Or rather, since a *debacle* was generally conceived as a vast torrent sweeping over the land, arising from the emergence of a submarine area, or some such cause, we may say that a *wave of translation*, in such cases as we have considered, is *a debacle travelling along the sea* after it has been shot off the land.

2. *On the Slow Transmission of Heat through loosely coherent Clay and Sand;* by James Nasmyth, Esq.; communicated in a letter to Leonard Horner, Esq., P.G.S., (Lon. Quart. Jour. Geo. Soc., Aug. 1847.)—When I lately had the pleasure to see you at the foundry, on drawing your attention to what appeared to me a remarkable example of the low capability of mineral substances for conducting heat, I was much gratified to find that you agreed with me in considering that the instance in view had an important bearing on several interesting geological questions, especially those relating to the theory of the central heat of the earth.

At your request I have much pleasure in sending you a statement of the instance in question, under the impression that it may chance to prove of some interest as an illustration of what may yet exist in respect to the state of the interior of the globe, as regards its high temperature.

The case, you will remember, was that of a large plate-iron pot, containing eleven tons of white-hot melted cast-iron—a temperature so high as to be quite beyond all thermometric certainty, but well-known to be the highest intensity of furnace heat, being quite equal to that of welding hot iron.

This vast mass of white-hot melted cast-iron, you will remember, stood in the pot for upwards of twenty minutes, and but for a thin coating of clay and sand of about half an inch thick, would have soon melted the bottom and sides of the pot.

This half-inch thickness of mineral substance, however, was quite sufficient to prevent the conduction of the heat to the exterior; so completely so, that after this vast mass of hot iron had remained for upwards of twenty minutes in the pot, you could place your hand on the side of the vessel without feeling any inconvenient degree of heat; and, as I mentioned to you, so slowly and imperfectly does this thin lining of half an inch of clay and sand permit the heat to pass outwards, that the entire mass might rest there till it became cool ere the outside of the pot would have reached a temperature high enough to carbonize wood in contact with it, the radiation from the outside carrying away the heat as *fast* as the *slow* conducting power of the clay and sand lining transmits it.

So striking an instance of the low conducting power of such substances is not frequently met with, and it appears to me that it is calculated to remove some of the doubts occasionally expressed respecting facts which indicate a high temperature in the interior of the earth. If half an inch of mineral matter thus intercepts the communication of so high a temperature as that of a mass of eleven tons of white-hot cast-iron, what may not two or three hundred miles of similar substances effect, in preventing the central heat of the earth from developing its action beyond a very moderate extent towards the surface? If this reasoning be correct, it tends to show that there may exist below the crust of the earth, a mass of fluid molten matter which at depths of two or three hundred miles may have a temperature transcending all our ideas of high heat, the only indications of which, at the surface, are afforded by volcanos, hot springs, and that regular increase of temperature as we descend towards the interior found in deep mines, or by deep borings.

There are many other instances of this nature which I could bring forward, as exhibiting the remarkable non-conducting power of clay; many such examples are every day before the eyes of our manufacturers who have to do with furnaces where intense heat is employed. The fire-brick lining of such furnaces is only from 4½ to 9 inches thick, and yet while the heat within is as high as our furnace powers will carry it, the hand may be placed outside without suffering any inconvenience.

3. *On the Changes of the Vegetable Kingdom in the different Geological Epochs;* by M. Adolphe Brongniart, (Edin. New Phil. Jour., Jan. 1848; from L'Institut, No. 714, p. 280.)—The changes which have taken place in the nature of living beings, since their first appearance on the globe till the period when the surface of the earth, having assumed its present form, has been covered by the creation which now occupies it, constitutes one of the most interesting departments of geology: it is the history of life and its metamorphoses.

The progress of modern geology presents to us the surface of the globe becoming renewed many times since the period when life first appeared upon it, under the influence of Creative Power. At each of these modifications—every time that a great bed of mineral matter covered a portion of the earth's surface, or a shaking of the crust of the globe wrinkled this surface, and produced new chains of mountains, the living beings which inhabited our earth, destroyed and buried in these sedimentary deposits, were replaced by a new creation more or less different from the preceding.

It would be a difficult task at this moment to fix precisely the number of these successive creations of animals and vegetables; but science is every day leading us nearer to this result, although it requires more detailed facts to enable us to reach it.

At certain epochs, however, great changes in the physical state of our planet have been followed by modifications equally great in the nature of the beings which inhabit it.

These are the very decided changes which alone deserve our attention in the present instance; for, on the one hand, they shew us each of the two organic kingdoms passing through varied forms, of which the different degrees are of great interest, owing to the remarkable order in which they succeed each other; and, on the other, the nature of the beings which correspond to each of these great geological periods, may afford us most valuable indications respecting the physical state of the earth, and its climate, at these different epochs, illustrative of the history of the formation of our globe.

From the most remote historical times, the vegetables inhabiting our globe have undergone no change. This is proved by the comparison of grains and plants preserved in the tombs of Egypt, with those which now grow in that country.

On the contrary, the plants of the latest geological periods,—those which occupied the earth before the last revolution of its surface, and whose remains are enclosed in the deposits named tertiary formations,—differ very considerably from such as now grow in these same places. They are, in general, species no longer existing in a living state, and their differences, relatively to the plants now living on the same ground, are greater as they occur in the more ancient beds of these tertiary formations. The most recent indicate a climate differing little from that of temperate Europe; the most ancient announce a warmer climate than now occurs in that region.

But in all these beds, which are very recent when compared with the other parts of the crust of the globe, we find vegetation, as a whole, agreeing in all its principal features with the mass of the vegetable kingdom which still inhabits the surface of the earth; there are the same classes, the same natural families, often the same genera. The general characters of this extinct vegetation are the same as those of the existing vegetation, and we might suppose ourselves merely transported to another quarter of the globe. Viewed as a whole they are the same; the details only are different.

But if, on the contrary, we descend more deeply into the layers composing the earth's crust, and go back to the more ancient periods of the creation; if we consider the vegetables preserved in the formations named secondary, which have preceded those of which we have spoken by many ages, we shall find the vegetable kingdom reduced to a much less considerable number of those natural groups which we name families or classes.

This variety of form and aspect, which gives such a charm to the existing vegetation, did not then exist; and, to characterize in a word the vegetable kingdom of those remote periods, we may say that the plants composing it, much less varied and numerous than those now covering our ground, were all deprived of what constitutes their greatest

ornament, namely, those flowers with brilliant envelops which belong to almost all the plants of our period. All the vegetables of the first geological periods were in fact analogous to our firs and ferns, whose habit and elegant foliage form all their beauty.

In these ancient times of geological history, we may farther distinguish two great periods; the one nearest our own times, during which terrestrial vegetation, almost entirely limited to three families, the ferns, Coniferæ, and Cycades, presented only species so far analogous in their most essential characters to those now existing, that they may be easily classified in the natural families I have just named; the other, more ancient, to which the vegetables belong that have produced great deposits of coal, and numerous remains of which accompany beds of this combustible. The latter recede much more widely from actually living forms, enter with more difficulty into known families, evidently constitute other families altogether distinct from those of our actual creation, families whose existence was not prolonged beyond this first geological period.

The singular organization and great dimensions of these first inhabitants of our soil, have long thrown much obscurity over the great classes of the existing vegetable kingdom. Every day, however, the study of them is advancing, and now we can no longer doubt that these gigantic vegetables, so remarkable by their extraordinary forms and by their structure, constitute special families, allied, however, to the ferns and Coniferæ; (that is to say, belonging to the great divisions of vascular cryptogams, and gymnospermous phanerogams.)

In conjunction with many true ferns, often arborescent, and with some Coniferæ, very different from those of our climate, these vegetables must have formed vast forests growing on a turfy soil, produced by their detritus, and to which our coal owes its origin.

Thus, briefly to recapitulate; during the earliest periods of the creation of living beings, the vegetable kingdom was composed only of plants belonging to the two classes of that kingdom distinguished by the simplest structure. These plants had then special forms, were of considerable dimensions, and the greater part constituted families now extinct.

At a later period, these two great classes still continued to exist alone on the earth, but their forms approached more to those which they present in the present vegetation; the families peculiar to the most ancient epochs were already destroyed, and the numerous and varied families which were to appear in the tertiary epoch did not yet exist.

Lastly, during this latter period, vegetation assumes characters analogous to those it now presents. The more perfect vegetables, known by the name of angiospermous phanerogams, appeared in great numbers, and the vegetable kingdom is not distinguishable from that now existing but by characters of detail, or by differences analogous to those which diversities of climate still produce on the earth.

If we now compare the vegetables of the families which, like the ferns and Coniferæ, have been perpetuated during all the geological periods, from the most ancient up to the present, we perceive that such as belong to the most remote creations, are most allied to the plants of those families which now inhabit regions of the earth having a climate

very different from our own ; and that such, on the contrary, as we meet with in the most recent beds, become more analogous to the species which still grow in these same countries, as the geological period to which they belong approaches nearer our own.

Every thing, therefore, proves, on the one hand, that the different vegetable creations which have succeeded each other on the globe have become more and more perfect ; on the other hand, that the climate of the surface of the earth has been greatly modified since the earlier times of the creation of living beings up to the commencement of the present epoch.

4. *Geology and Topography of the Isthmus of Panama ;* by Evan Hopkins, C.E., F.G.S., (Mining Journal, April 8, 1848; translated from the Bogotá Gazette of the 9th Sept. 1847.)—By reference to a prepared plan, it will be observed that the Cordillera of mountains, forming the chain of union between the two Americas, is curved in the shape of an arc on the Isthmus of Panama—the convex side faces the north, the easterly portion runs in a south-eastern direction towards Darien, and the south-west prolongation extends to the shores of the Pacific, from whence it again takes a westerly turn towards Veragua. The westerly part of the curve, between the rivers Trinidad and Gorgona, is broken, and the continuity of the chain interrupted by the oblique intersection of the River Chagres. Towards the north-east, between the sources of the Boqueron and San Blas, the chain forms a broad mass of great elevation, and sends out numerous lateral branches, from which the rivers Chagres, Pequeni, and Boqueron take their origin, and also the Cascajal, which runs to the north. The old road to Portobello, which I took on crossing the Isthmus the second time, follows along the Boqueron principally on the bed of the river, owing to the rocky and precipitous nature of the banks, until numerous and deep waterfalls over basaltic rocks, which exist near its source, render it necessary to leave the river, and travel along the steep sides of the surrounding mountains. The heads of this river consist of various branches, one of which arises from the break existing in the Cordillera, at an elevation of 700 feet, where the road across the mountain is carried ; and from the same point another stream runs to the north into the River Cascajal. In consequence of the great convolutions of this river, and the rugged and rocky nature of its bed, a day and a half was formerly spent in ascending it by boats from the point of union of the Pequeni to half its extent. The river and the road being synonymous terms in this route, our road continued descending as before, but rather in the waters of the Cascajal than along its banks, over the hard, slippery, sharp, and broken edges of the primary slates that traverse it, until we came to within a short distance of Portobelo. The great difficulties and obstructions, caused by inundations, which attend this route, and the choice made of such a direction, are a strong proof that the Spaniards found insuperable obstacles to the formation of a good road between Portobello and Panama.

From the pass in the mountain above alluded to, towards the west, the chain is divided into numerous longitudinal branches ; one proceeds from Portobelo, and terminates abruptly in the vicinity of this port, with an elevation of 600 feet ; the central branch falls towards the bay of El Limon, and the southern branch forms the limit of the River Chagres,

up to the mouth of the Trinidad, varying from 400 feet to 900 feet in height, and having a few peaks of still greater elevation. The space comprised between these three principal ridges is full of a multitude of smaller ones, which form the channels of the rivers Agua Lucia, Gatun, Aqua Clara, which fall into the Chagres, and of the Grande, Guanche, and Buenaventura, which discharge themselves into the Atlantic.

The gold washings of Santa Rita are situated on the central branch, between the rivers Clara and Grande. From the summit of the central Cordillera, at Santa Rita, (which was the direction of my third journey across the Isthmus,) a commanding view is obtained of the chain, from the elevated point of separation to the east, as far as Portobello, and, on the other side, of the whole length of coast of the Atlantic, as far as Chagres, and from hence to the Cordillera, in the vicinity of Cruces.

Reflecting on this elevated and dense mass of mountains, which intervene between Portobello and Panama, deeply furrowed by so many rivers, we are led to appreciate the difficulties of undertaking to construct any thing resembling a commodious road, diagonally from Portobello. I examined the Cordillera in the rear of Portobello; and it appears feasible to open a mule road on the summit of the external ridges, crossing the rivers near their sources, and gradually descending along the top of the south side, towards Cruces, or any other convenient point on the River Chagres. The peones sometimes follow this direction, which is called the new road, and it is, doubtless, preferable to that of the Boqueron. The distance from Portobello to Panama, in a direct line, is about 40 miles; by the Boqueron, including the turnings, 60; by the top of the Cordilleras, including deviations and turns, 58; from Chagres, along the River Gorgona, 42, and from Gorgona to Panama, 19=61; from the Bay of Limon, along the east bank of the Chagres, by Gorgona, to Panama, 35 miles. The last is the most direct and shortest road, and the one which appears to me to present fewer obstacles than any other to the formation of a railroad across the Isthmus. The Bay of Limon is equally the only port, besides Portobello, adapted to this purpose, on the Atlantic coast, within the described limits.

The corresponding part of the principal chain to the south of the Chagres, near Gorgona, is divided into a number of conical mountains; but, further on, towards the centre of Trinidad, they unite into a cordillera, of an average elevation of 500 feet. The space between this chain and the river of Trinidad is composed of marshy flats and isolated pyramidal mountains. An opinion prevailed, that there existed an almost uninterrupted level from the junction of the Trinidad with the Chagres, and that a canal could be easily cut in this direction, which would simply require locks (*represas*) at each extremity; but this allusion has been destroyed by Senor Garella, chief engineer of the royal corps of miners, who examined this portion of the Isthmus, and informed his Government, that it would be necessary to construct 33 locks (*represas*) and a large tunnel, to effect this object between the two seas. Assuredly, the great obstacles presented by the locality to an undertaking of this nature, place such a plan out of the question—so gigantic a work as a canal for vessels, which would require so much capital and time, must be left to a future generation, when the commerce and prosper-

ity of this portion of the globe shall justify such an undertaking. The time has, nevertheless, arrived, when public attention should be directed to some practical end, as the traffic between the two seas across the Isthmus is on the increase, and, consequently, some immediate and important improvement is required to facilitate the transit.

The surface between Gorgona, Cruces, and Panama, gradually, and with gentle undulations, slopes towards the Pacific, and is covered with various groups of conical hills, decomposed rocks, colored clay, sand, and loose stones. A section, from the mouth of the River Chagres to Chonera, presents a very gradual ascent, as far as the marshy land near the base of the Cordillera of Trinidad, then a rapid ascent of 450 feet, followed by a corresponding fall to the Pacific. A section, from the center of the mines (*Ensenada de minas*) at Panama, shows a succession of deep undulations as far as Gorgona, and from thence a gradual fall to the coast. Another section, from Portobello, begins with a rapid ascent from the port; it then follows the turns of the rocks and falls of the rivers Grande and Gatun, amounting to an elevation of 1000 feet, and concludes with a rapid descent to the River Chagres. A diagonal section, from the mouth of the Chagres, along the river, as far as Gorgona, and from thence to Panama, embraces the lowest point of depression between the two seas; the highest point in this section is between the River Grande, and the Obispo, which does not exceed 150 feet; consequently, with regard both to level and distance, this line offers greater attractions and facilities than any in another direction, for making an easy and comparatively cheap communication across the isthmus.

Notwithstanding the want of a port at Chagres, and the excellency of the port of Portobello, the first place is made use of, and is at present the only profitable point for the transit. As there is little or no coasting trade (*comercio costonero*) worth mentioning, nor any internal trade, the ports are necessarily rendered dependent on the facilities offered by the localities for the purposes of internal transit: this is the reason why Chagres has deprived Portobello of its shipping, and caused it to be almost abandoned. There ought to be some prospect of increase in the internal resources—*i. e.*, in the production and consumption, and not merely in the transport, to justify the formation of any thing better than a good mule-road from Portobello to the south of the great chain. A good mule-road would answer for passengers, money, and light articles; but it would not serve the general purposes of commerce, as it would probably increase the expenses and delays, and would be more exposed to deterioration than the present road; it would increase the advantages of shipping, but it would add to the cost of transit; whereas, what is required, is to give increased facility to the transit, in order to secure the advantages and pre-eminence of this route by the isthmus; the shipping would necessarily increase, and ways and means would be found to provide commodious ports, or rather to improve the existing ones for their reception.

It appears to me that this great question, of improving the communication between the two seas, ought to be considered as a *sine qua non* by the Government, and that every reasonable stimulus ought to be given, by removing commercial restrictions, in order that the work may be un-

dertaken with the probability of its being completed without delay. It is sure to be executed some day, therefore the sooner it is taken in hand the better. The advantages that it would cause to be derived by the western coast of New Granada, independent of the isthmus, would be immense.

The geological character of the isthmus is very simple, and is easily examined. With the exception of the schistose channel, which crosses it in the meridian of the Boqueron and the granitic line between Pequeni and San Blas, the whole is composed of porphyritic and hornblendic rocks, which gradually pass from one to the other, and run in large layers, more or less, in a northerly direction. The schistose rocks are largely developed in the Boqueron and the Cascajal, and the laminated structure of the hornblendic rocks is well defined, their inclination varying from east to west, according to the contortions and other disorders arising from the lateral pressure in the mountains enclosing them. The predominant ingredients are visible in the mass, and give rise in the rock to numerous colors, as black, green, blue, white, brown, and bright red.

From this part of the chain to the west, the mass is hornblendic, but subject to the usual variations in its structure, alternating between porphyry, greenstone, and basalt, conformably to the changes in the relative proportions of hornblende and feldspar. There is a great deficiency of silica in these rocks; quartz in crystals, veins, or masses, is rare; lime is equally scarce, but iron is very abundant, and exists in different degrees of oxydation. These rocks are very susceptible of decomposition, particularly when iron is the predominant ingredient; large fragments of decomposed rock, containing globular pieces, which resist ulterior decomposition, are numerous, and constitute the principal superior masses of the isthmus.

This sort of spherical exfoliating decomposition, until scarcely a vestige of the original rock is perceptible, is common enough in the granites and porphyries of the Andes, and the fissures are also frequently found filled with a species of efflorescence of black ferruginous sand; and when this is auriferous, the gold is found mixed with iron. In the course of time, the pieces scale, and the masses crumble; and, being gradually carried by the rains to the cavities and valleys, secondary deposits are formed of marl (*greda*), sand, conglomerate, or gravel, which, in these warm climates, are soon consolidated into compact beds.

The town of Panama is situated on secondary argillaceous deposits, in layers and fragments of comparatively recent date, and very strongly impregnated with iron. A great part of the upper portion of these deposits to the depth of several inches on the sea shore, is composed of oyster-shells and red sand; interstratified, are found soft seams of aluminous white magnesia, and likewise some yellow and grey layers, appropriate for building—some of which are sufficiently soft *in situ*, but become harder by exposure to the sun. The green and blue varieties, which are found of different degrees of hardness, are susceptible of rapid decay, owing to the absence of siliceous, or calcareous, matter in the original compound, to form a cement for binding together the sedimentary deposits. Lime for building is a marine production, obtained principally from shells; and, in consequence of the excess of phosphate, and the absence of silicate of lime, and pure argillaceous sand, there

is great difficulty in obtaining a good composition for works exposed to the action of water, or hydraulic lime. Even to make lime for ordinary purposes, the utmost care is required to wash the saline matter from the shells; if this be neglected, the lime is spoiled, and does not easily bind. The foregoing secondary deposits—those of Barbacoas—the white argillaceous deposits between Cruces and El Pequeni and Caimitello, are all the secondary rocks I have seen. There are a few calcareo-aluminous rocks, interstratified with feldspathic deposits, near St. Juan, but, correctly speaking, they are not deserving of notice. The lime on the shores of the Atlantic, and likewise the building-stone, is obtained exclusively from the coral rocks, which so beautifully and exuberantly vegetate on the hornblendic shore of Portobello. The town and fortifications of Portobello are entirely built of coral, and they appear very durable. The persons who have hinted at the existence of limestone and freestone quarries, in the Isthmus of Panama, must have been mistaken, and were evidently unacquainted with the geological position of these rocks The question will now naturally arise—where are we to procure materials for a road in a country where there is so absolute a deficiency of these requisite articles? because, in case of either improving the present mode of transit, by means of an ordinary road, or making a road for carts and horses, in both cases it will be requisite to prepare the localities intended for the reception of cattle and construction of bridges.

Gravel, or hard and rough stones, can be obtained from the decomposed basaltic rocks; the friable sandstone must be rejected, being unfit to make a hard and durable surface; which, by means of a cart-road, can easily be conveyed to any part of the line, and with much greater economy than by the ordinary road. It will be necessary to make the bridges high and wide over the Gatun and the Chagres, which can only be effected by means of timber, judiciously combined with wrought-iron, constructing them on the principle of *obra de legadura*—the sketches of which, including the road and quay (*muelle*) of Panama, will be forthcoming in due time, together with an approximative calculation of the cost. In case the medium line should not be determined on for the ordinary road cutting, and constructing dykes and bridges, the advantages of a carriage-road over a mule-road would be trifling. In reality a *soft* road, embracing a number of useless ascents, and following the undulations of the precipitous hills, would be inferior to a good mule-road. It is important to consider this point attentively beforehand, to avoid the mistake of supposing that a mule-road, converted into a carriage-road, would produce the anticipated advantages. If the gradients are well executed, it is a feasible project to construct a railroad (*ferro carril*) from the Bay of Limon along the eastern bank of the Chagres—and this can be performed with a moderate outlay, the transit performed in nine or ten hours, and merchandise transported with celerity, and at an insignificant cost; one horse on a railroad (*ferro carril*) will do the work of six on an ordinary road; the casual and necessary expense will be less, and the best materials could always be procured, owing to the great facility of transport.

The foregoing observations have reference to the transit from sea to sea; they have no connection with those provincial works and improve-

ments which are being carried on, and which are so much required to facilitate the traffic between different parts of the country.

Mines.—There are no metalliferous veins in the Isthmus of Panama within the limits above described. Notwithstanding that, generally speaking, the porphyritic hornblende is auriferous, the gold is very sparingly disseminated; and, in the absence of lodes, or fissures, in the rocks, no natural concentration takes place; and, consequently, the precious metals cannot be obtained until the rock is decomposed, and the gold partially concentrated in pools, by the agency of the rains. The inhabitants of these auriferous districts are well acquainted with the places in which the gold is collected; they are also expert washers; notwithstanding, in consequence of the small quantity of gold obtained, and the excessive labor required to remove the accumulation of stones, they seldom gain more than 4 rials a-day—rather less than more; and yet, in the face of repeated misfortunes, they are so infatuated with this work, that they are unwilling to abandon the labor of searching for gold, in order to direct their energies to a more certain and profitable occupation. Sometimes rich pools (*pozos*) are found—this is reported to have taken place at Santa Rita and Pequeni; these fortunate casualties serve to keep alive the interest felt, and, when they occur, they generally occasion the loss of much useful capital and labor, by the excitement produced, and the consequent search for gold lodes; which mistaken notion is fostered by the supposition that all minerals, or metals, must proceed from lodes; under the same erroneous impression, poor gold lodes are worked—their only merit consisting in vague traditional reports, that some rich deposits had been formerly discovered in the vicinity. The gold washings are commonly called "mines," and the term *mine* leads to the supposition of the existence of metallic veins, on account of the vague signification given by miners to metalliferous deposits. The gold-washers give the name of *lode* to all the small seams of ferruginous deposits, though they may be widely different in their character from true *lodes;* and, consequently, persons entering into these ruinous speculations, who are unacquainted with their nature by practical experience, are deceived; and, unfortunately, the elementary books on these subjects, instead of giving information, add to the confusion—and thus it happens, that capital is frequently thrown away on useless speculations. The gold washings of Santa Rita and Pequeni are the product of decomposed auriferous rocks; and the gold is, as it always happens, of much purer quality and better standard than that obtained from lodes. The decomposed deposits of Santa Rita and Pequeni, situated on elevated Cordilleras, are very unfavorably placed for water; the present washings are limited to the portions washed by the rains during the rainy season.

I have found a few specimens of hepatic iron in Pequeni, and great quantities of the peroxyd and protoxyd of iron; but as these can be of no service in this part of the world, it is unnecessary to dilate thereon; it is also useless to allude to the presence of silver, the descriptions already given being sufficient for the purpose.

Very fine trees are to be seen on the banks of the Gatun, especially of the species called cedar. Having crossed the isthmus three times, I penetrated, on foot, through forests and rivers, and have been exposed to

heavy rains, day and night, without suffering in health. I have no reason, therefore, to consider it as unhealthy as it is reported to be.

The population appears small and inadequate for the purpose of public works; but I have been assured laborers can be procured from some parts of the interior. I am, however, of opinion that, if any important works are undertaken, an additional and more effective set of hands would be indispensable.

5. *Geology and Mineralogy of the Malay Peninsula*, (Mining Journal, April 22, 1848.)—The little that is known of the physical geography and geology of the peninsula of India, renders the most general information of the greatest interest. The knowledge of this immense tract, extending over 83,000 geographical square miles—the interior of which is almost untrodden ground, at least to European foot—must depend on future exploration; but any information, even of its coast line and adjoining islands, is of importance, and tends to incite to further observation. Its western coast is remarkable for the great number of islets which skirt it; a broad and almost uninterrupted belt extends along all the western side of the isthmus. Some of these are remarkably bold and imposing—such as the Johore Archipelago, and the Redang Islands. The concave southern half embraces the Island of Singapore; and an archipelago of several hundred miles, stretching southeast by south, marks that the peninsular zone has not yet wholly sunk beneath the sea, and attests how nearly a junction with Sumatra has been accomplished. Most of the Islands are bold; and one of them (St. Matthew) rises to the height of 3000 ft. The isthmus itself is occupied by numerous high hill ranges, which have the same general southerly direction. Along the sea borders, considerable tracts of flat alluvial land occur, the best known of which is the large plain of Tenesarim. From Junk-Ceylon to the Langkawi group, the coasts of the main land and Islands exposed to the full force of the Bengal Sea, are broken, and frequently rocky and precipitous. The high and perpendicular limestone rocks, with their deep excavations, pillared with colossal stalactites and with their summits crowned with dense forests, present the most magnificent scenery. The Island of Penang is a bold mountain mass, rising in some of its northerly summits to the height of nearly 3000 ft., and contrasting nobly with the broad and beautiful plain which lies opposite to it, on the main land. Geologically, the peninsula may be considered, when divested of its alluvial fringes, as one continuous belt of mountains and hills, separated from the Hindu-Chinese region in lat. 13° 30′ north. We find that the broad tract, stretching eastward towards Siam, Cambodia, Cochin-China, with which the peninsular zone is amalgamated, is not a uniform elevated continental mass in which the peninsula merges, as the straits of Malacca lapse in the Sea of Bengal. The zone of elevation continues uninterruptedly—the western border being a broad sheet of alluvium; beyond this alluvium, another elevated zone occurs, succeeded by a second tract of alluvium, which again is bounded by a third elevated belt. How far to the north these great alluvial plains extend, and how much the northern limit of the Malay Peninsula has been pushed south by the gradual filling up of the northern part of the Gulf of Siam, we have no authentic knowledge. The rocks are principally plutonic; but considerable masses of sedimentary rocks oc-

cur, consisting of limestones, sandstones, common clays, and shales. In the famous tin island (Banca) the prevailing stratified rocks are clays and sandstones. In many cases plutonic action has indurated the superincumbent strata, converting sandstones into compact siliceous rocks and clays, and conglomerates into schist and other hard crystalline forms. In Malacca are several thermal springs. This fact, combined with some proofs of recent upheaval, leads to the surmise that it still retains the character of a rising region—a surmise which its proximity to Sumatra countenances.

Metals.—The tendency to the production of metalliferous ores at and near the junction of plutonic and sedimentary rocks, which has been observed in many countries, might have led us to anticipate a large share of metallic riches for the peninsula. In reality, it probably abounds in some ores far beyond conception.

Iron ores are every where found, and in the south they exist in vast profusion. In some places the strata have been completely saturated with iron; and here the bare surface of the ground, strewed with blackish scoriform gravel and blocks, presents a strange contrast to the exuberant vegetation of surrounding tracts, appearing as if it had been burned and blasted by subterranean fires. Much of the ordinary forms of ironmasked rocks, which are so common, and so little regarded for their metallic contents, that in Singapore they are used to macadamize the roads, contain often nearly 60 per cent. of pure metal.

The whole length and breadth of the peninsula, there can be little doubt, abounds in tin ore. The uniformity, we might almost say unity, of its plutonic character, warrants the inference that ores, found plentifully in many different and and distant localities where they have been sought for, exist also in the intermediate tracts which have not yet been examined. At the two extremities of the peninsular zone of elevation, Junk-Ceylon and Banca, tin sand is diffused in such quantity that its collection has never had any other limit than the number of persons employed in it. In Junk-Ceylon and Phunga, under a barbarous government, about 13,000 piculs are annually dug out of the soil. In Banca, under a European government, but without any improvement on the usual Chinese mode of excavating, washing, and smelting, the production has increased from 25,000 piculs, in 1812, when it was a British possession, to 60,000 piculs.

At numerous intermediate localities throughout the peninsula tin is obtained; and when we consider the despotic, rapacious, and, too often, remorseless character of the native governments, the consequent failure of all attempts to introduce European or Chinese capital and system into the tin mining, and the robberies and massacres which, from time to time terrify and scatter the little communities of needy Chinese in whose hands it has remained, the wonder is, that so much metal should find its way to the market. In the Siamese countries north of Kedah, and in Kedah itself, which has been so long in a state of anarchy, it is sparingly extracted. From Perak 9000 piculs per annum was formerly exported, but the produce has now greatly diminished, owing to the miserable state of the country. Sálángor and the adjacent inland states yield about 1000 piculs. The eastern countries from Kalatan to Pahang yield about 11,000 piculs. The present produce of the whole peninsula, in-

cluding Sinkep and Linga, the only two islands of the Johore Archipelago where it is now sought for, is probably above 40,000 piculs. The produce for many years past has ranged between that quantity and 30,000. The peninsular range, therefore, including Banka, yields upwards of 100,000 piculs, so that it equals, or exceeds, that of Cornwall (6000 tons), and may be expected to increase steadily.

Seeing that tin is procured in all parts of the peninsula where it is sought for, and, in proportion to the enterprise and labor which are devoted to the search, we may consider the entire zone as a great magazine of tin. It is, in fact, incomparably the greatest on the globe. Johore might have seemed to offer an exception to the apparent universality of the distribution of oxyd of tin, if its geological affinity to Banca, the fact of tin having from time to time been found in several places, and for many years having been got in considerable quantity in Malacca, had not afforded the strongest presumption that its want of inhabitants and government was the cause of its nonproductiveness. The last eighteen months, however, have placed the matter beyond doubt, and given a striking proof at once of the metallic fertility of the country, and of the little attention which this branch of industry has hitherto met with in the British settlements. In 1845, Malacca, an integral part of Johore, and having the same geology as the rest of the country, produced about 450 piculs of tin. In the succeeding year the interest of some Chinese of capital was excited in the subject, and more vigorous and extensive operations were commenced. In 1846 above 1400 piculs were procured, the greater part from 39 pits in one valley. In 1847 the produce appears to have been from 4000 to 5000 piculs. In 1848 it will probably rise to between 5000 and 7000 piculs, for the government tithe upon it for the year has been rented for the unprecedented sum of 8190 Sp. dollars ; the revenue from this source having been, in the two preceding years, $1020 and $3345 respectively.

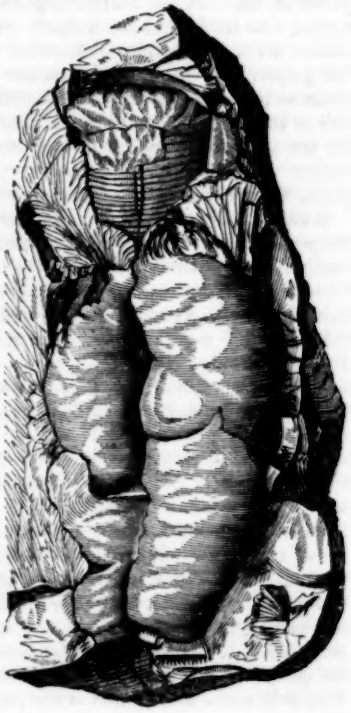
Nothing can better show how entirely the metalliferous character of the peninsula has escaped the mining enterprise of private European capitalists, than the fact, that in the Island of Singapore, where we have a line of junction between plutonic and sedimentary rocks, of above 20 miles in length, where tin was found in former years in at least two localities—and where the same iron ore, with which it is associated in Banca, abounds both in the igneous and aqueous rocks—no interest has ever been awakened in the subject. In the peninsula and Banca, tin has hitherto been procured by digging pits in alluvial tracts where the ore is found, generally intermixed with quartz particles, in a state resembling sand, varying from fine to coarse, and may properly be considered stream ore. Large specimens are found with the ore, adhering to, and partially invested with, quartz. We are not aware that it has ever been actually seen in the solid rock in the peninsula, but in Banca it is found associated with iron ore in veins in the granite. A Dutch writer also describes whole layers as occurring in some mountains, which consist partly of granite, but in the centre principally of layers of sandstone and quartz, in which iron ore also appears. In the more purely granitic mountains, it seems to have been observed in quartz at the junction of the granite, with the iron-veined sandstone strata. In the Isthmus of Krá, it has also been found at the junction of sandstone and granite. In Cornwall, it appears to be dependent on granite.

The finest ores of Banca yield as much as 80 per cent. of metal—the common sorts from 40 to 60. The quality of the peninsular ores has not been ascertained so carefully; we are not aware that more than 70 per cent. have been ever obtained.

We have dwelt, at some length, on tin, because it is the principal natural production of the peninsula, which derives from the fact of its being the greatest stanniferous tract in the world—an importance, economically, which has never been sufficiently appreciated. The existence of tin in Banca was unknown until 1709, when it was accidentally discovered. Now its produce doubles that of the peninsula, although the latter has a surface 18 times larger. The reason is not a mineralogical one: it is because in Banca the Chinese are stimulated, furthered, and protected, by a strong government which directly interests itself in their operations.

Gold is found in the peninsula, but whether from inferiority of enterprise, or natural deficiency, not in such abundance as in those parts of the adjacent countries of Sumatra and Borneo, where it is systematically dug for. The present annual produce is probably about 20,000 ozs. In all the larger specimens which we possess, or have seen, it is disseminated in small particles, and streaks, in quartz. Like the tin ore, it has not been seen in the undisintegrated state. Copper, silver, and arsenic, have been detected in Banca, but apparently in small quantities.

6. *On an Impression of the Soft Parts of an Orthoceras.*—The accompanying figure represents a specimen from a bed of shale alternating with compact limestone, near Cincinnati, Ohio, described by Mr. J. G. Anthony in the Quart. Jour. of the Geological Society, 1847, p. 256. Mr. Anthony observes, that the Orthocerata of the locality were associated with numerous fossils of the "Hudson river group," and they were remarkably well preserved, the Lingulæ being erect, as if entombed in the position in which they lived; the trilobites unusually perfect. On the Orthocerata, he remarks, that they frequently measured over three feet in length. "They all appeared more or less compressed, as if by the weight of the superimposed strata, and their diameter when thus flattened was frequently over six inches. The surface was often coated with a black substance, like paint; where this was removed, it appeared rough, almost like shagreen. My attention was however particularly drawn towards the



smaller specimens, each of which was enveloped in a sac, an appearance which I had never before noticed in connexion with these remains. This sac was of an oval form, about twice the diameter of the enclosed Orthoceratite, enveloped its whole length, was like it flattened, and had a longitudinal depression through its entire length. Upon seeing it, the idea was at once suggested that here was a solution of the question, never before determined, with regard to the form and texture of the body of the Orthoceratite. Though very widely distributed through various strata, yet the soft parts have been so completely destroyed by time and circumstances, that no discovery of them had been hitherto made, by which even a surmise could be formed of the organization of the animal. * * * From the present discovery, we may reasonably suppose that they were furnished with a fleshy body, like the Sepia of the present day and its kindred cephalopods, or perhaps like the Belemnite of the antediluvian creation with its accompanying ink-bag. If they were provided with this latter apparatus, might not the black coating so common upon them be a deposit from that dark liquor?" * *

We have received a communication on Mr. Anthony's paper, from Mr. James Hall of Albany, who takes the ground that what is represented as due to the soft parts of the Orthoceras, is a result of concretion about the fossil. He mentions and figures numerous examples of similar appearances about fossils of various kinds, Orthocerata and others, which are nothing but a result of a concretionary structure; and states that such forms are most common in the fine soft shales. The striated surface and bilobate form are common in the New York specimens. Moreover, it is doubted that the "soft parts" could become petrified, or retain their form sufficiently during the decay which immediately follows death to give it to the enclosing material.

7. *Effect of Fusion on the Density of Rocks.*—In the last volume, p. 258, some facts are given relative to the change of density in different siliceous minerals, in consequence of fusion and their assuming a vitreous state. Delesse has experimented upon this subject, and gives the following table containing the diminution of density for the different rocks mentioned: (Jour. de Pharm. et de Chem., xiii, 68.)

Granites, quartzose porphyry and granitoid rocks,	9	to 11	per ct.
Syenitic granite, syenite, - - - - -	8	to 9	"
Red, brown, green porphyry, with or without quartz, and having a base of albite, oligoclase, andesite,	8	to 10	"
Diorite and dioritic porphyry, - - - - -	6	to 8	"
Melaphyre, - - - - - - - -	6	to 7	"
Trachyte, - - - - - - - -	4	to 5	"
Ancient volcanic rocks and basalt, - - -	3	to 4	"
Modern volcanic rocks and lavas, - - -	0	to 3	"

8. *Talus Slopes.*—In the chains of the Vosges and Jura, Leblanc found no talus exceeding an inclination of 35°. This slope, he observes, is most rigorously, the inclination of the diagonal of a cube. The density of the material has no effect on the slope, as the avalanches of snow and fall of rocks take the same slope. Some rough rocks, as trachyte and sandstone debris, may form a declivity of 37° to 39°. A talus of 42° to 45°, is not one of stable equilibrium.

9. *Burra Burra Copper Mine, South Australia.*—The Burra Burra Copper Mine, is the most remarkable one in South Australia. A correspondent of the Mining Journal, (No. 651,) makes the following remarks:—"You are aware that the property consists of 10,000 acres (the remaining 10,000 belonging to the Princess Royal Company), divided into 2,464 shares, of 5*l.* each, paid up; or, 12,320*l.* capital. *Two* dividends, of 2*l.* 10*s.* per 5*l.* share (or 50 per cent.), have been paid in July, by which the whole of the original has been returned; a *third* dividend, of 5*l.* per share, or 100 per cent., has just been declared; and, probably, every month or six weeks will see a similar one! The merchants have lately established a sort of market for the purchase of the ore from the different mines as it arrives at the port. Hitherto, the banks would only advance 6*l.* or 8*l.* per ton, even on the best ore. Now, the merchants, who, from the flourishing state of trade, have large remittances to make to their constituents in England, and would otherwise have to pay a premium to the bank for bills of exchange, purchase the ore from the mining companies on the following plan;—parties are now, from experience, able to give a pretty fair guess as to the probable metallic contents of a heap of ore; the Burra Burra Company thus sell 100 tons, for instance, to A. B., guaranteeing that 100 tons at 20 per cent.; A. B. takes an average of the price of metal, from two or three of the last Swansea sales, and says, for that heap, I will give you such a standard; another merchant will, perhaps, raise a little on it—so that virtually, the only price settled here and paid for, is the price of the copper metal; the merchant running the risk of profiting or losing by a rise or fall of the metal by the time the ore arrives at Swansea. Should the heap, when sold, be found in Swansea to contain 25 per cent., instead of 20 per cent., then A. B. makes good the difference to the company. In the other case, of a less produce, the mine makes good the difference to A. B. The arrangement suits both parties. A. B. saves premium on bills of exchange, and makes a commission on sale of ore in England. The mine instead of having to wait twelve or eighteen months for the net proceeds, being formerly only allowed to draw barely enough to pay for the prime cost of ore, now is enabled to divide profits as fast as the ore is delivered at the port."

In another part of the same number of the Mining Journal, we read—"it appears that, in about eighteen months, these mines have yielded the extraordinary amount of 9841 tons of rich copper ore—so rich, that its total value amounted to 150,000*l.* The original purchase money of the mines, together with the costs of working, from September, 1845, to March, 1847—the year and a half in question—is something under 75,000*l.*, which has been wholly repaid to the shareholders, in two dividends, of 50 per cent. each; and the directors are about to declare another dividend of 100 per cent. We make no comment whatever on this extraordinary statement. We suppose it to be without a parallel in the whole history of mining successes. A large part of the ore has arrived at Swansea for smelting, another portion is on its way, and a remnant of some 1600 tons will be forwarded to this country, or America, with as little delay as possible."

10. *Histoire des Progrès de la Géologie de* 1834 *à* 1845; par Le Vicomte D'Archiac. Publiée par la Société Géologique de France,

sous les auspices de M. Le Comte de Salvandy, Ministre de l'Instruction Publique. Tome Premier. *Cosmogonie et Géogenie, Physique du Globe, Géographie Physique, Terrain Moderne.* 680 pp., 8vo. *Paris*, 1847.—In a science advancing with the rapidity of geology, a work like the one before us, giving a review of its progress for a period of years, is of great value to science. The laborers in the field are scattered over the whole civilized world, and these publications are in many languages.

The difficulty of commanding the works issued, is especially felt in America, where libraries in science are slowly supplied with European publications, particularly the Transactions of the various learned societies of different countries. Moreover, few have the time requisite to study and digest thoroughly the publications within reach. M. d'Archiac has done an invaluable service to geologists, in his labors. The work is divided into chapters and sections. Each chapter contains a fair and interesting review of the subject of which it treats, and is followed by a list of publications. The following are the subjects treated of in this, the *first* volume: 1. Cosmogony.—2. Geogeny—constituting the *First Part.*—*Second Part:* 1. Size of the Earth, Irregularities of Surface and Density.—2. Interior temperature of the globe.—3. Meteorology.—4. Terrestrial magnetism and electric currents within the earth.—5. Physical Geography.—6. Orography and Relief of the Continents.—7. Hydrography.—8. Continental Depressions.—*Third Part:* On Modern Deposits and Phenomena upon the Earth's surface—1. Atmospheric and Terrestrial products.—2. Aqueous and Glacial products.—3. Lacustrine and Fluviatile Deposits.—4. Vegetable and Animal productions of these deposits.—5. Marine Deposits.—6. Organic productions of the last.—*Fourth Part:* Phenomena originating beneath the Earth's Surface.—1. Gaseous, Bituminous and Saline.—2. Mineral and Thermal Waters.—3. Volcanic products.—4. Earthquakes.—5. Elevations and Subsidences.

This volume is to be followed by a *Second* on the Diluvial or quaternary and tertiary strata; a *Third* on the secondary and intermediary or Transition strata—and a *Fourth* on Primary rocks, Palæontology, Theories of Elevation, Subsidence, Veins, and Metamorphism, Analysis and Structure of rocks, Artesian wells, Meteorites, Selenology, together with a Bibliographical Supplement, a review of the bibliographical statistics of each country, and a list of authors cited in the four volumes.

The work should be in the hands of all interested in geological science.

III. Botany and Zoology.

1. *Gutta Percha.*—The tree affording the gutta percha, of which an imperfect description was given in our last volume, p. 438, has been referred to the new genus *Isonandra*, of Wight. Dr. Wight described two species, to which M. A. De Candolle has added two others referred hitherto to Sideroxylon. W. J. Hooker calls the species affording the gutta percha, *Isonandra gutta.*

2. *On the Eyes of the Balanus;* by Dr. LEIDY, (Proc. Acad. Nat. Sci., Jan. 11, 1848, p. 1, vol. v.)—Dr. Leidy remarked, that the existence of eyes in the perfect condition of the Cirrhopoda, has been denied by all anatomists up to the present time, but its presence in the larva or imperfect stages is very generally acknowledged. Several years since, having received some living specimens of *Balanus rugosus* adhering to an oyster, he submitted them to dissection, in the course of which, he noticed upon the dark purple membrane which lines the shell and muscular columns running to the opercula, on each side of the anterior middle line, a small, round, black body, surrounded by a colorless ring or space of the membrane, which, upon submitting to a low power of the microscope, he found to be an eye, composed of a vitreous body, having nearly two-thirds of its posterior part covered by pigmentum nigrum, and attached to a nervous filament, which he afterwards traced to the supra-œsophageal ganglia. The presence of this organ in other species or genera, he had not yet had an opportunity of determining.

3. *A comparison between Sterna Cantiaca*, Gm., *of Europe, and Sterna acuflavida*, Nobis, *hitherto considered identical with S. Cantiaca, and a description of a new species of Wren;* by Dr. CABOT, (Proc. Bost. Soc. Nat. Hist., Nov. 17, 1847, p. 257.)—The following measurements from adult, full-plumaged specimens were given:

American.	Millimetres.	European.
Bill along ridge,	49	57
" " gape,	64	75
From the nostril to the point of the bill,	36	41
Length of nostril,	6	9
Length of lower mandible along the centre, (measuring to the feathers,)	41	47
Length of do. do. along the side, do. do.	51	62
Width of bill at commencement of feathers,	8	7½
Depth of do. do. do.	11¼	12½
Length of wing from flexure,	290	317
Length of tail to tips of lateral feathers,	136	149
Length of tarsus,	25	28
Middle toe without the claw,	18	21
Middle claw,	7½	9
Inner toe with claw,	17	20
Outer do. do.	21	26
Thumb,	6½	8½

Besides these differences in the measurement of parts not subject to change from improper stuffing, &c., we find that the coloring differs in some very important particulars. In the American bird the yellow is strictly confined to the tip of the bill, and the line of union of the yellow and black is perpendicular and unbroken, whereas in the European bird the yellow runs up to the inner edge of the symphysis on the under side of the lower mandible, and almost as far on the upper edge; and on the upper mandible also, it extends both on the edges and on the ridge much higher than in the American bird. The primaries are much darker in the American bird than in the European, and the white

line which runs along the inner edges and forms their tips in the European bird, disappears in the American before it gets within half an inch of the tip; besides being much narrower. There are also some important differences in form. The projecting point at the symphysis on the under side of the lower mandible is more marked in the American than in the European bird. The claws of the European bird are larger and much more arched than those of the American. The bill of the European bird is much narrower in proportion than the American, and is more bent.

The specimen of *S. acuflavida* in his collection was procured at Tancah, on the coast of Yucatan, on the 25th of April, 1842, and is mentioned in the appendix of Mr. Stephens's Incidents of Travel in Yucatan, under the name of *S. Boysii.*

Troglodytes albinucha, a new species of Wren.

	Millimetres.
Total length,	140
Length of wing from flexure,	58
" tail,	51
" head and bill,	38
" bill along the ridge,	17
" bill along the gape,	22
Width of bill at feathers,	3½
Depth " "	3¾
Length of tarsus,	20
" middle toe with the claw,	22
" inner toe " "	15
" outer toe " "	16
" thumb " "	17

The bill is bent from the base to the tip. The claws are much curved and very sharp. The head, back, and upper sides of the wings and tail, brown; a line of white, with black or dark brown intermixed, passes over the eye, and meets with a similar line, which passes under it, and they form a patch on the sides of the neck extending round to the nape. Chin, throat, and breast white; flanks and abdomen light yellowish brown, darkest near vent. On the rump are some white and dark brown or black spots intermixed with the brown of the rest of the back. Under tail-coverts, the outermost, and outer webs of next three tail-feathers, and outer edges of first and second primaries, barred with white or yellowish white, and dark brown or black. There are many black bars running across upper side of wings and upper tail-coverts. The four middle tail-feathers are brown, with many black spots. The upper mandible is dark horn color; the under mandible is the same at its tip, but is almost white on the under side and at base. The fourth and fifth primaries are longest and the first is shortest.

The specimen from which the description was taken was the only one observed, and was procured near Yalahao, in Yucatan, April 6th, 1842.

4. *Notice of a fractured and repaired Argonauta argo;* by C. B. Adams, Professor, &c. in Amherst College.—The familiar examples of the repair of the shells of Mollusca are interesting, since they illustrate the mode of growth of the shell.

We have before us examples in which the whole of the last whorl has been destroyed and reproduced. On account of the extraordinary relations subsisting between the animal and the shell in the genus Argonauta, a fractured and repaired shell possesses more than usual value.

In the collection of shells in the cabinet of Amherst College, is an individual of the Argonauta argo, which appears to furnish an additional argument in support of the opinions which are based on the researches of Madame Power. In this shell a portion has been broken out near the middle of the left side, and not far from the sinus of the aperture. The opening was of a semilunar form, about $1\frac{3}{4}$ inches long, with an average breadth of half an inch. A new deposit of testaceous substance, together with a broken fragment, has closed the opening in the rude manner common in the shells of Mollusca.

But the most extraordinary circumstance is this; that a fragment, which was broken out in the accident which befel the animal, now constitutes two-thirds of the repaired portion, and that the originally inner surface is now the outer surface, as is evident from its concavity, style of undulation, and texture. It is also nearly at right angles to its original position. These facts show that the piece was totally detached from the shell by the accident.

We apprehend that a case could scarcely occur, especially in a shell moving in water, except in consequence of the functions now ascribed to the vela of the Argonaut. These once-reputed sails, performing the less poetic function of clasping and enveloping the shell, prevented the loss of the large fragment.

It is obvious also that the new deposit of testaceous matter, was secreted from the part of the animal within the shell, and not from the vela, since the edges of the original shell around the fracture appear exclusively on the outside.

Since none but the original inhabitant of the shell could repair it, the case described is corroborative of the opinion, that the animal usually seen in these shells is the original owner.

5. *Description of a Species of Haliotis, supposed to be new;* by C. B. Adams, Prof. &c. in Amherst College, (communicated for this Journal.)

Haliotis ponderosa: H. t. magnâ, ovatâ, crassissimâ, convexâ; striis incrementi magnis, irregularibus; rugis concentricis, irregularibus, subnodosis; spirâ elevatâ, subterminali; foraminibus quatuor, magnis; externè rubrâ, intùs maculis plurimis rubris viridibusque iridescente.

Shell ovate, convex, ponderous, with coarse unequal incremental striæ and concentric ridges (not folds), and a few broad low tubercles on the ridges; spire elevated, subterminal; four perforations open, the inner one very large; exterior surface brick red; inner surface elegantly iridescent with innumerable shades of delicate red, purplish red, and green.

Length $8\frac{1}{2}$ in.; breadth $6\frac{2}{3}$ in.; depth within $3\frac{1}{8}$ in.

Comparison with the well known *H. rufescens*, Swains., will render a figure unnecessary. A large specimen of Swainson's shell before me, has exactly the same superficial dimensions, but is only $2\frac{1}{2}$ inches deep. *H. ponderosa* is nearly or quite destitute of the spiral waves of *H. rufescens*, is of a darker red without, wants the red inner margin

of the outer lip, and within has the clouds of iridescent colors remarkably small and numerous, while in *H. rufescens* they are remarkably large. It is more ponderous than any Haliotis which we have seen, weighing 2 lbs. 2 oz. avoirdupois.

Zoological Museum, Amherst College. Hab. —— ?

Not finding this species in Reeve's very complete and excellent monograph, I have ventured to describe it as new.

IV. Astronomy.

1. *Lord Rosse's Telescope*, (Lond. Athenæum, April 8.)—At the meeting of the Dublin Royal Academy, March 17, 1848, Dr. Robinson gave an account of the present condition of Lord Rosse's telescope. Dr. R. found that the speculum (whose figure, as he had formerly stated, was not quite perfect) as well as a duplicate one, had been polished by the workmen; and as he apprehended no difficulty in the process, it was repeated. An unexpected difficulty however occurred, which made much delay, till Lord Rosse discovered the cause. The success of the operation requires that it be performed at the temperature of 55°. In winter this must be obtained by artificial heat,—which however increases the dryness of the air, so that the polishing material cannot be kept on the speculum. In this case the surface is untrue, and gives a confused image. This was verified by the hygrometer, and remedied by a jet of steam so regulated as to keep the air saturated with moisture. The result was immediate; and at the first trial the speculum acted so well, that it was unnecessary to try any further experiments. Three additions had been made to the telescope: 1. The movement in right ascension is given from the ground by machinery intended to be connected with a clock movement which is in progress. 2. To obviate the difficulty of finding objects, an eye-piece of large field and peculiar construction is connected with a slide, so that it can be replaced by the usual one in an instant. It magnifies 208 times, and employs nearly four feet of the speculum, the same as Herschel's 40-feet; thus giving the power of trying what that instrument might show. 3. The micrometer is peculiar,—a plate of parallel glass, with a position-circle attached. Light admitted at its edge cannot escape at the parallel surfaces except they be scratched, and a scale of equal parts engraved on one of them with a diamond—luminous in a field absolutely black. The exceedingly unfavorable state of the weather subsequently prevented much from being done; in fact, there was but one good night, the 11th ult. In the moon he observed the large flat bottom of the crater covered with fragments, and satisfied himself that one of the bright stripes which have been often discussed, had no visible elevation above the general surface. In the belts of Jupiter, streaks like those of Pyrrhus's cloud were seen; and the fading of their brown color towards the edge, is evidence that they are seen through a considerable and imperfectly transparent atmosphere. A similar shade in the polar regions, where little cloud is to be expected, seems to indicate that the brighter bands are cloudy regions, and the more dusky show the body of the planet. Several nebulæ were examined, and as formerly all were resolved. That of Orion is most remarkable. Even

before the mirror was perfect and in bad nights, the part of it which presents the strange flocculent appearance described by Sir John Herschel, is seen to be composed of stars, with the lowest power, 360. But Dr. Robinson's eye required 830 to bring out the smaller stars, amongst which these are scattered. Having seen them and known the easier parts, they were seen with the 3-feet and 500. * * * * Another interesting object is the planetary nebula, *h.* 464, situated in the splendid cluster, *Messier* 46, and probably a part of it. It is a disc of small stars uniformly distributed, and surrounded by the larger. *Messier* 64 is a singular modification of the annular form seen obliquely. The opening seems black as ink, and at its margin is one of those interior clusters of bright stars so often noticed before. But the most remarkable nebular arrangement which this instrument has revealed, is that where the stars are grouped in spirals. Lord Rosse described one of them (*Messier* 51) in the year 1845; and Dr. Robinson found four others on the 11th, of which he exhibited drawings, *h.* 604 (seen by Herschel as a bi-central nebula), *Messier* 99, in which the centre is a cluster of stars. *Messier* 97 looks with the finding eye-piece like a figure 8, but the higher powers show star-spirals related to two centres, appearing like stars with dark spaces around them,—though probably high powers in a fine night would prove them to be clusters. Another fact deserves to be noted from its bearing on Struve's *Etudes d'Astronomie Stellaire.* In that admirable book, among other curious matters, he infers that the eighteen-inch telescope of Herschel penetrated into space only one-third of what was due to its optical power. He explains this by supposing the heavenly spaces imperfectly transparent. In computing the limit, however, he assumes that the Milky Way is in its greatest extent "unfathomable by the telescope." Dr. R. however chanced to observe it when it is deepest at 6–4, and is certain that its remotest stars were very far indeed within the limit of the six-feet, and very much larger than those of the nebula of Orion.

2. *New Planet*, (Lond. Athenæum, May 6, 1848.)—A new planet was discovered by Mr. Graham, at Markree, Ireland, April 25, 1848. It appeared like a star of the tenth magnitude; R.A. $14^h\,55^m$, S. declination $12°\,32'$; daily motion in R.A. $1^m\,7^s$ retrograde. It is supposed to belong to the group between Mars and Jupiter.

3. *Supposed new Star*, (ibid.)—A new star of the fifth magnitude in the constellation Ophiuchus, was noticed at Mr. Bishop's Observatory, London, April 28, 1848. No star has been previously recorded in the position of this. It is in a line joining *eta* and 20 *Ophiuchi*, rather nearer to the latter; R.A. $16^h\,51^m\,1^s$, S. decl. $12°\,39'$. It is some degrees distant from the place of the famous object seen by Kepler in 1604.

4. *On the opinion of Copernicus with respect to the Light of the Planets;* by Prof. De Morgan, (Phil. Mag., xxxi, p. 528.)—The common story is, that Copernicus, on being opposed by the argument that Mercury and Venus did not show phases, answered that the phases would be discovered some day. The first place in which I find this story is in Keill's Lectures. It is also given by Dr. Smith, in his well-known Treatise on Optics, by Bailli, and by others. But I cannot find it mentioned either by Melchoir Adam or Gassendil, in their biographies of

Copernicus; nor by Rheticus, in his celebrated *Narratio*, descriptive of the system of Copernicus; nor by Kepler, nor by Riccioli, in their collections of arguments for and against the heliocentric theory; nor by Galileo, when announcing and commenting on the discovery of the phases; and, what is most to the purpose, Müler, in his excellent edition of the great work of Copernicus, when referring to the discovery of the phases of Venus, as made since, and unknown to, Copernicus, does not say a word on any prediction or opinion of the latter.

This story may then be rejected, as the gossip of a time posterior to Copernicus. If we try to examine what the opinion of Copernicus on this matter really was, a point of some little curiosity arises. It depends on one word, whether he did or did not assert his belief in one or other of these two opinions,—that the planets shine by their own light, or that they are saturated by the solar light, which, as it were soaks through them. I support the affirmative: that is to say, I hold it sufficiently certain that Copernicus did express himself to the effect that one or the other of these suppositions was the truth.

If we take the first edition of the work *De Revolutionibus*, which was printed from the manuscript furnished by Copernicus himself, there is little doubt about the matter. There are but two passages which bear or can bear upon the question. The first is in the *ad lectorem*, in which the writer (Osiander, though even Delambre make him Copernicus) asks whether any one acquainted with geometry or optics can receive the Ptolemaic epicycle then used to explain the motion in longitude of Venus? But the meaning of the allusion to optics is explained in the next sentence, by a reference (and by no means a fortunate one) to the changes of apparent diameter of Venus derived from the epicycle; changes which, as they made the perigean diameter more than four times as great as the apogean, were assured to be falsified by common experience. The second passage is the one on which this discussion must turn. In book i, chap. x, after noting that some had heretofore believed Mercury and Venus to come between the earth and sun, he mentions the difficulty arising from the absence of the remarkable phase, which we now call the transit over the sun's disc. He describes the opinion just mentioned favorably, referring, not to his own view, but to that of those others who had held it. This is not an uncommon idiom: persons advocating an unpopular opinion are very apt to describe the maintainers of it in the third person, though themselves be of the number. But when he comes to describe what he takes to be the necessary consequences of the opinion, he lapses into the first person as follows:—"Non ergo fatemur in stellis opacitatem esse aliquam lunari similem, sed vel proprio lumine, vel solari totis imbutas corporibus fulgere, et idcirco solem non impediri . . . . ."

These are the words of the first edition (Nuremberg, 1543). That Copernicus could have answered any objection, either by word or writing, is impossible, since he drew his last breath within a few hours of the time when, not able to open it from weakness, he saw the first printed copy. The second edition (Basle, 1566) is usually said to have been edited by Rheticus. The reason of this is that the name of Rheticus appears in the title-page. But this appearance only arises from the *Narratio*, &c. of Rheticus being added to the edition; and it is

only the description of this edition which brings Rheticus into the title-page. There is no mark whatever of his having been the editor; and as the work was printed at Basle, where I cannot find that Rheticus ever sojourned, and as the latter was deeply engaged at the time in his enormous trigonometrical calculation, some proof of his editorship must be given before it is admitted. As the point is of importance, I will notice, that unless Rheticus had made some stay at Basle, it is very unlikely he should have edited a work printed there. He did not edit the first edition, only because it was found convenient to print it at Nuremberg instead of at Wittemberg; and it was accordingly entrusted to Osiander. Now, if ever there were a connexion between two men, and between one of them and the book of the other, which made it desirable and even necessary that the first should edit the second, it was the case of Rheticus and the first edition of the *De Revolutionibus*, &c.; and yet no arrangement could be made by which the sheets printed at Nuremberg could be revised at Wittemberg. It is very unlikely, then, that Rheticus should have edited the second edition, when, as far as we know, a similar impediment existed.

The third edition by Müler (Amsterdam, 1617), has no authority as to the text above that of the second.

Now both the second and third editions change the word *fatemur* into *fatentur*, thus causing Copernicus to throw the opinion in question upon his predecessors, instead of directly making it his own. Not that it would be conclusive, even if the emendation were adopted: for, as I have said, Copernicus is evidently speaking with approbation of the opinions which he describes; and it would be difficult to say why *comperiunt* or *putant* in one sentence should imply approbation, and *fatentur*, in the next, should be at least disavowal, if not disapprobation. If Rheticus, who knew the mind of Copernicus better than any one, had been the editor, I can conceive that stress ought to be laid upon the change of the first into the third person as an emendation; that is, I should be somewhat staggered by Rheticus having thought it necessary to make such an alteration.

But, Rheticus not being in the question, as I think, for the reasons given above, the next best authority on an opinion of Copernicus is Galileo. Now the latter, in speaking of the phases of Venus, expressly attributes to Copernicus the maintenance of one of the two alternatives, —that the planet is either self-luminous or perforated by the solar rays. Of these alternatives, he says, in his letter to Velser (Works, vol. ii, pp. 88, 89), "Al Copernico medesimo convien amettere come possibile, anzi pur come necessaria una delle dette posizioni." And that such was the opinion of Copernicus is also assumed by the writer of the note on the *Sydereus Nuncius* in the volume just mentioned, and by others, even down to our own time; as by Mr. Drinkwater Bethune, in his life of Galileo. In fact, with the exception of the unsupported story mentioned at the beginning of this paper, there is nowhere, that I can find, any thing against my conclusion. And it is to be remembered, that Copernicus nowhere shows any of that acumen in matters of physics, apart from mathematics, which has often enabled the cultivators of the former to make steps more than proportionate to their knowledge of the latter. Ptolemy, the great promotor of the old theory, and Coper-

nicus, its destroyer, were both mathematicians in a peculiar sense; Ptolemy being far the more sagacious in questions of pure experiment. Their grounds of confidence are mathematical; and Copernicus, in particular, dares to face his own physics (for there is no reason to suppose he was beyond his age in mechanical philosophy) with reasons drawn entirely from probabilities afforded by mathematics.

There is much reason to regret the practice of associating with the names of those who have led the way in great discovery the glory which is due to their followers. The disadvantage is twofold. In the first place, it introduces into the history of science an index error of from one to two centuries; secondly, those who come to inquire are disappointed to find that they must lower their opinion of great men, and are perhaps led to do it to a greater extent than justice requires. Our usual popular treatises speak of Copernicus as if, besides himself, he had in him no inconsiderable fraction of Kepler, Galileo, Newton and Halley. What is a person to think who comes from these histories to actual investigation, when he finds in Copernicus himself the immovable *centrum mundi* (only reading sun for earth) of the Ptolemaists, their epicycles, and a suspicion, at least, of the solid orbs?

5. *Solar Parallax.*—A Report was submitted to Congress in April last, with reference to setting on foot an expedition to the most southern available position on the western Continent, for the purpose of making observations on the planet Venus during the period of her retrograde motion: these observations are to be conjoined with similar observations at the Observatory in Washington city, with a view to determining, more accurately than has hitherto been done, the solar parallax. The plan emanated from Dr. Gerling of Marburg, well known for his astronomical and geodetical labors, and was communicated by him in a letter to Lieut. Gilliss, dated April 17, 1847, in which he earnestly seeks for the coöperation of American astronomers. The correspondence on the subject between Dr. Gerling and Lieut. Gilliss, addressed by the latter to the Chairman of the Committee of Naval Affairs of the House of Representatives, was made the basis of the Report. The object is one worthy of a national expedition. The Report states that in 1769, Dr. Rittenhouse, under the patronage of the government of Pennsylvania, made observations on the transit of Venus that were of great value. The subject is therefore already connected with the history of American science, under the auspices of government patronage.

V. Miscellaneous Intelligence.

1. *Memoire sur les Temperatures de la Mer Glaciale à la surface, à de grandes profondeurs, et dans le voisinage des Glaciers du Spitzberg;* par Ch. Martins, Membre de la Commission Scientifique du Nord. (Extrait des Voyages en Scandinavie, en Laponie, et au Spitzberg de la Corvette la Recherche, Geographie Physique, ii, 279. Paris, 1848.—The following are the results of these valuable researches, as laid down by the author. They relate to the temperature of the sea near the icebergs in the two bays of Spitzberg.

1. In the month of July and August, the surface temperature, although very near the freezing point, is always above it.

2. From the surface to a depth of seventy meters (about 76½ yards), the temperature is sometimes increasing and sometimes decreasing.

3. Below seventy meters to the bottom, it is always decreasing.

4. The decrease between the surface and the bottom is not a uniform rate, but goes on accelerating with the depth.

5. Between the surface and seventy meters in depth, the temperature is never below zero (freezing point).

6. Below seventy meters, the temperature of the bed covering the bottom is below zero.

7. The mean temperature of this bed is −1°·75 Cent., and consequently it is above that of the maximum density and freezing point of salt-water.

8. These facts are easily explained, if we consider that the maximum density and the point of congelation of sea-water are several degrees below zero, and if also we regard the complex, intermittent and variable intensity, caused by the solidification of the surface during winter, the icebergs, floating ice, the tides and currents.

These results, M. Martins continues, are fertile in applications to the physics of the globe. We learn from the fact of the temperature increasing in April and May, that in winter the surface cools more than the bottom, and that consequently the formation of *ground ice*, common in fresh-water lakes, is here impossible. Scoresby and Ross ascertained by direct trials that no ground ice exists, and farther brought up living animals in many instances.

As the temperature of the surface of the sea in July and August, near the glaciers, is above zero (Cent.), it is easy to understand their constant destruction and the formation of floating ice. These glaciers, moving slowly from the land into the sea, for the same reason, melt on reaching the water, and are borne on its surface. At low tide, as the waters retreat, the interval between high and low water is well seen in the glacier; at the same time it becomes broken, or overturned, and thus floating ice is produced. The largest glaciers were seventy-six meters high, and furnished floating masses ten meters in elevation; but generally the detached portions break to pieces and produce what is called *brash*, or *drift ice*.

In Baffin's Bay, on the contrary, the glaciers advance into the sea without being melted. John Ross has described and figured a glacier, to the north of Cape Dudley Digges, which advanced 1800 meters (5906 feet) beyond the shore. The floating ice, consequently, is often higher than the mast of a ship, and the masses are well called *icebergs*, or mountains of ice. As the part above water is about one-eighth of the whole thickness, these bergs have been described as 72, 113, and even 180 meters in depth.

The height of the floating ice is a consequence therefore of the thickness of the glacier, and the shore and bottom temperature of the sea. Upon the coast of Spitzberg, washed by the warm waters of the Gulf Stream, the floating ice is small, whilst in Baffin's Bay, where there is no such stream, the temperature of the surface of the sea is almost always below the freezing point, and the glaciers advance into the sea, sliding along its bottom, without much diminution at base.

2. *Indurating Building Materials*, (Mining Journal, April 15, 1848.) —Our attention having been called to an advertisement of Mr. Hutchinson's indurated stone, &c., we were induced to visit the office, and among the extraordinary discoveries of the present day, by which materials of the most humble pretensions in works of art are rendered of the utmost utility—the most refractory substances made to bend to the power of scientific research, and many productions, which have for ages been thrown away as useless, brought into most extensive usefulness—we know of none by which a more extraordinary, not to say magical metamorphosis is effected, than the operation patented by Mr. Wm. Hutchinson, by which plaster of Paris, Bath, Caen, and other soft stone, chalk, wood, pasteboard, and, in fact, any other material, is rendered hard as metal, receiving the most brilliant polish, and made absolutely imperishable from atmospheric action, vermin, &c. The purposes to which this patent can be applied are innumerable. The first idea of the patentee was the induration of the softer and more common, and almost useless, stones for the purpose of paving; but so complete was his success, that he soon took a loftier view; and has rendered the operation, not only applicable to all common purposes for which stones and slates are used in building—such as paving, both internal and external, window-sills, cisterns, fittings of dairies, &c.—but now applies the operation to all the higher works of art. Plaster of Paris casts, of the most elaborate designs, in bust, relievos, architectural ornaments, fonts, and ornamental flooring for churches, trellis work for balconies, ornamental inkstands, &c., are rendered imperishable by the operation of the elements, and hard and tough as metal. Sculptors who may so choose, may work in Bath or Caen Stone, or even chalk, and the production will be rendered superior to marble; and in all these operations the finest edges of the cuttings are preserved, and not a chisel mark is lost.

In inspecting specimens of Mr. Hutchinson's works, we were shown a slab, of soft fine sandstone, from Tonbridge Wells—so soft, that it might be rubbed into powder by the hand—rendered hard as granite, and rung like a bell; numerous plaster of Paris ornaments and busts, metamorphosed into bronze, granite, and party-colored marbles—drain, water and gas pipes, made from Bath stone, chalk, or paper, hard as granite, and polished internally like marble; in fact, the results of the operations are most extraordinary. The water-pipes, and prepared sheets for roofing, will be found most economical, both in first cost and in wear and tear; in fact, they can be rendered at a cost which comes far below any other description of material which has yet been introduced for these purposes; the sheets would also be highly applicable for railways, and many other public engineering uses. We recommend the attention of the engineers architects, sculptors, builders, &c., to this interesting patent, which, we feel assured, will prove of great public utility. Mr. Hutchinson has also a model of a stone-sawing machine, which performs its work most perfectly by hand labor—entirely superseding steam machinery.

Works are already established in London, Caen in Normandy, and at Tonbridge Wells, in Kent. The patents, works, &c., are divided into twelve shares, of 3000*l.* each—two-thirds of the value to form the

working capital, and the original proprietors retaining four shares. Parties will be treated with for the remaining eight shares.

3. *Coal in Chili*, (Mining Journal, Feb. 12.)—We have, on various occasions, alluded to the mineral resources of Chili, which stand pre-eminent among the republics of South America. Lately, several extensive coalfields have been discovered between Valparaiso and Santiago, but one in particular, belonging to an English firm, a short distance from the port of Valparaiso, is likely to prove a most valuable speculation, as it is being worked, and the coal equal to that of Newcastle, which can be delivered at the rate of 4*s.* per ton, whilst but a short time ago none could be obtained at a less price than 2*l.* to 2*l.* 10*s.* Several miners have arrived out there from the north of England and from Australia, at high wages; and as the parties who have got the property and concessions, are chiefly British, and strongly patronized by the government, there is little doubt that these seams will be worked on a large scale, as native laborers (*peones*) may be obtained at a very low rate. To the progress of steam navigation in the Pacific, the facility of obtaining coal in Chili, will be a most important advantage; but to mining adventurers it will be the means of greatly developing her mineral resources, by the establishing of steam-engines, furnaces and smelting-houses, on the spot, instead of sending the ore to Europe to be reduced; roads are being cut in every direction, and water conveyance will be easy of access in the interior.

4. *Metallurgical Industry of Bohemia*, (Mining Journal, Feb. 12.)—It appears, by a paragraph in the *Prussian Gazette*, that metallurgical industry has, within the last few years, made considerable progress in Bohemia. Although at present there are not more than fifty establishments in operation, these have produced 470,000 quintals of metal in the course of one year, valued at 2,000,000 thalers (280,000*l.*) This quantity, it is stated, is very little below the entire production of the provinces of Silesia, the Rhine and Westphalia, where strenuous endeavors have been made to push this branch of business. The mineral resources of Bohemia are described to be most extensive; and, according to the statement quoted, have scarcely yet been properly developed.

5. *On the Jordan and Dead Sea;* by the late Lieut. Molyneux, of H.M.S. Spartan, (Athen., Apr. 1.)—On the 20th of August last, Lieut. Molyneux landed at Acre, taking with him three volunteer seamen and an interpreter; and having hired camels, horses, and attendants, he started early the following morning with the ship's dingey *en route* to Tiberias. For the first two hours the road was excellent. On nearing the village of Abilin its character altered; the country became hilly, and some awkward passes were encountered. The village of Taran was reached the same night, after ten consecutive hours of travelling. On the following day the party arrived at Tiberias, where they encamped outside the walls of the town and near the edge of the lake. Immense herds of camels were seen feeding in different directions. From the hills overlooking Tiberias the prospect was magnificent;—Djebel Sheikh, smothered in clouds, was distinctly seen to the left, bearing N.N.E.; in front were the blue waters of Tiberias, surrounded by fine ranges of hills; and to the left of Djebel Sheikh the white ruins of Safed.—On the 23d, they embarked on the lake, which is described

as being of greater size than is generally laid down;—from Tiberias to the eastern shore not less than eight or nine miles, and from the entrance of the Jordan on the north to its exit at the south end, eighteen miles: the latitude of the northern extremity of the lake is 32° 49′ 9″, about 3½ miles to the south of the point usually marked. The Jordan is described as shallow, and crossed by numerous weirs, which greatly obstructed the passage of the boat. In many places it might have been crossed by stepping from stone to stone without wetting the shoes; its waters are muddy and full of fish; its course tortuous in the extreme, and some waterfalls were found. Great reluctance was manifested by the natives towards the purposed descent of the river, and every possible obstacle thrown in the way. The Sheikhs demanded in some cases exorbitant sums for permission to pass through their provinces; and altercations, annoying and incessant, were generally terminated by a display of fire-arms, and the threat to shoot them unless they allowed the party to proceed.—On the 3d of September, Lieut. Molyneux embarked on the Dead Sea. The breeze gradually freshened, till there was quite enough sea for the dingey: steering about south by west, large patches of white frothy foam were several times passed; and as the sea got up there was heard a most unusual noise, something like breakers a-head. At 2 A.M. on the 4th, considering they must be approaching the south end of the sea, they hauled to the wind and stood over towards the western mountains; and at daylight were about five miles from the peninsula. From Ras el Feshkah to the north, nearly down to the peninsula to the south, the mountains on the western side rise, almost like a perpendicular wall, to a height of 1,200 or 1,500 feet. The peninsula is connected with the main land by a low neck, so that at a distance it would be considered an island. Having arrived at what was thought to be the deepest water, soundings were obtained at 225 fathoms; the arming of the lead was clear, with some pieces of rock-salt attached to it. Two other casts of the lead were taken at different times; one gave 170, the second 183 fathoms, with bluish mud or clay. The water throughout the Dead Sea is of a dirty, sandy color, resembling that of the Jordan; it is extremely destructive to everything that comes in contact with it, particularly metals, and produces a very unpleasant, greasy feel when allowed to remain on the skin; it has also a very obnoxious smell. At noon on the 5th they returned to the tent whence they embarked, thoroughly done up and thankful for having escaped. Every thing and body in the boat was covered with a nasty shiny substance from the water; iron was corroded and looked as if covered with coal tar. No fish or any living thing was found in the water of the Dead Sea. A broad strip of white foam running nearly north and south throughout the whole length of the sea was observed, not commencing where the Jordan empties itself, but some miles to the westward; it appeared to be constantly bubbling and in motion, and over this, on both nights, was a white line of cloud far above the surface. Having disembarked, the dingey was secured upon the backs of two camels, and the party procee ded to Jerusalem,—within the walls of which town entered the boat of a British ship-of-war. Lieut. Molyneux returned by way of Jaffa; and died shortly after his return to his ship.

6. *Level of the Caspian and Dead Seas.*—The Caspian Sea, according to A. Erman in 1836, is 84 meters (266 feet) below the level of the Black Sea. The Scientific Commission from the Russian government in 1837, found it 101·2 feet (English). M. H. de Hell has concluded from a barometric leveling, that the difference of level between the Caspian and Sea of Azof, is only 18·304 meters. From the geodesic results of Sabler and Sowitsch, M. Hell deduced 33·7 meters, and afterwards 27, as the difference of level. From the same observations, Humboldt obtained 81·4 feet (English).

M. Cailler (1839) deduced from the observations of Bertou (1837 and 1839), Moore and Beet (1837), and Schubert (1837), as a mean, that the Dead Sea is depressed 185 meters below the Mediterranean. Bertou placed it at 419·6 meters. David Wilkie (in 1842) found the depression 365 meters; Lymonds, 427 meters; Rusegger (1841) 434 meters. Delcros (1843) derives from all the observations, that 426·3 meters is the amount of depression. Moore and Beck sounded 300 fathoms in the Dead Sea without finding bottom.—*D'Archiac Hist. Geol.*

7. *Cremastochilus in Ant Nests;* by S. S. Haldeman.—Our ant nests are similar to those of Europe, in harboring various insects. Among these are Aphis, Coccus, Batrisus, Hister, Hetærius, and the singular genus of Lamellicornia mentioned above. About the end of April, I found beneath a flat stone, in a cavity occupied by a large flavous species of ant, a living *Cremastochilus variolosus*, but laid no stress upon the occurrence, as I supposed it to be accidental. On the 16th of May, I took three individuals of *C. Harrisii* together, under similar circumstances, and kept them alive for twelve days. On the 25th of May, I found a second individual of *C. variolosus*, in an ant's nest. The locality is a southern hill slope covered with Castanea, Pinus mitis, Acer, Carya, and Kalmia, the soil siliceous. The genus is extremely rare; although tolerably successful in collecting, and my residence is near the locality, these are the first living individuals I have seen. In confinement they burrow beneath the earth in which they are placed, the head, from its peculiar form, being well adapted for this purpose.

The genus Chelifer is also found in ant nests, where it is probably attracted by the immature Thysanura which occur there; but I recently found nine individuals apparently parasitic, lodged near the extremity of the abdomen, beneath the wings and elytra of a living *Alaus oculatus*, the early stages of which are passed in ash trees.

8. *Meteor;* by D. D. Phares, A.M. (from a letter dated Whitesville, Miss., May 8, 1848.)—On the night (Saturday) of the 15th ultimo, a brilliant meteor was seen to start a little west of north, and more towards the east, disappearing with a loud noise like that of a six pounder. It was described by those who saw it as appearing several inches in diameter, with a train several feet long. Persons in every part of this county saw it and heard the explosion. It was so bright as to cause opaque objects to cast a shadow even in the moonshine. I can hear of no part of the meteor being found.

9. *Common Salt.*—The amount of common salt in all the oceans, is estimated by Schafhæutl at 3,051,342 cubic geographical miles. This would be about five times more than the mass of the Alps, and only one-third less than that of the Himalaya. The sulphate of soda

equals 633,644·36 cubic miles, or is equal to the mass of the Alps. The chlorid of magnesium, 441,811·80 cubic miles; the lime salts, 109,339·44 cubic miles. The above supposes the mean depth to be but 300 meters, as estimated by Humboldt. Admitting with Laplace, that the mean depth is 1000 meters, which is more probable, the mass of marine salt will be more than double the mass of the Himalaya.

10. *Geological Map from Soundings.*—In a communication from Lieut. M. F. Maury, U.S.N., we learn that the proposition to construct a geological chart of our coast from the "records" of soundings, or the use of the *troll*, was suggested by him to the "National Institute" in December, 1840, thus anticipating Lieut. Bache.* The idea is not a novel one abroad. Lieut. Bache's proposition included beyond this, the constructing of the chart by glueing on, in its proper order, the material collected.

11. *Science at Cambridge.*—Hon. Abbott Lawrence has made a second donation of $50,000 to the Department of Science in Harvard University.

12. *Expedition in search of Sir John Franklin.*—This Expedition, under Sir James Ross, has left England. It consists of two vessels, the Enterprise and Investigator, the first of 470 tons and the latter of 420, which are built as strong as wood and iron can make them, with due reference to their sailing qualities. A launch is attached to each ship fitted with screw propellers, which are to be worked with steam, and will make on an average seven miles an hour.

VI. Bibliography.

1. *Researches on the Chemistry of Food and the motion of the juices in the animal body;* by Justus Liebig, M.D. Edited from the manuscript of the author, by William Gregory, M.D., and from the English Edition, by Eben N. Horsford, A.M., Rumford Professor in the University at Cambridge. Lowell, D. Bixby & Co. 1848, 12mo., pp. 219. —Prof. Horsford has conferred an acceptable service in promptly bringing out this edition of the last work of the great chemist whose name it bears. The title fully indicates the topics of discussion—which it is needless to say are handled with a master's hand. Some of the new views on the flesh fluids and upon endosmosis have already been presented to the readers of this Journal. (See vol. v, p. 415.) The two separate topics named in the title are the subject of distinct discussion under two heads, and form in fact two separate treatises. The volume will be eagerly sought by all chemists and physiologists, and it is not easy to say to which class it is most important.

2. *Carices Americæ Septentrionalis Exsiccatæ*, edidit H. P. Sartwell, M.D. Part I. Penn Yan. 1848.—Dr. Sartwell is well known as one of our most zealous botanists, and has long paid great attention to the vast and intricate genus Carex, as the rich collections which he has for many years so liberally distributed among botanists abundantly testify. His name is indissolubly associated with the genus in all our

* See page 318 of last volume.

current works and Floras. Wishing at length to distribute his admirable dried specimens of Carices in a more systematic way, he has prepared and published a choice series of specimens, seventy in number, with printed tickets and title-page, under the appellation given above. We understand that the sets are not on sale,—for no sum which they would be likely to command would afford any pecuniary compensation for the time and pains bestowed upon them,—but are intended for distribution among his botanical correspondents. Having been favored with a copy of this valuable *work*, the writer wishes to record his sense of the value of such well-authenticated specimens to all students of Carices—and they are many—and to state that the specimens are remarkably beautiful and complete. Several represent peculiarly rare and interesting species, such as *C. dioica*, which Dr. Sartwell discovered in this country. *C. scirpoidea*, *C. Willdenovii* and its near allies *C. Steudelii* and *C. Backii*; *C. Sartwellii*, *C. decomposita*, *C. Cruscorvi*, *C. alopecoidea* of Tuckerman, *C. Fraseri*, *C. tenuiflora*, *C. sychnocephala* of Carey, the recently detected American representative of *C. cyperoides*, *C. Liddonii*, *C. torta*, of Boott, *C. salina*, *C. flacca*, *C. livida*, and *C. Crawei*.

Trusting that Dr. Sartwell will continue this publication so as to furnish similar fine specimens of all our Carices, we suggest the propriety of adding the name of the collector to the ticket,—a point of the more importance since the loose specimens are likely to be distributed in herbaria apart from the title page,—and also of printing the habitat with sufficient fulness to indicate clearly the place intended. A. Gr.

3. *Statistics of Coal*; the Geographical and Geological Distribution of Mineral Combustibles or Fossil Fuel, including also notices and localities of the various Mineral Bituminous substances employed in the Arts and Manufactures, illustrated by numerous Maps and Diagrams, embracing four official reports of the great Coal-producing Countries, the respective amounts of their Production, Consumption and Commercial Distribution in all parts of the World, together with their Prices, Tariffs, Duties and International Regulations, accompanied by nearly 400 Statistical Tables and eleven hundred analyses of Mineral Combustibles, with incidental statements of the Statistics of Iron Manufactures derived from authentic authorities; prepared by Richard Cowling Taylor, Fellow of the Geol. Soc. London, etc., 754 pp. 8vo. *Philadelphia*, 1848.—The extent of the above work as regards whatever pertains to coal either scientifically or economically, is evident from the above title: and it is a sufficient guarantee for its completeness and accuracy on all points on which it touches, that it received before publication the highest and most unqualified praise at one of the meetings of the American Association of Geologists and Naturalists, which was followed by a general subscription for copies of the work. An examination of the volume, now that it has appeared from the press, gives us a still higher opinion of the talents and industry of its author, and the great value of his labors. It meets the wants of those economically interested in coal mines, by its various detailed information and statistics on mines at home and abroad; and the geologist finds a fuller account of the scientific history of coal deposits than is met with elsewhere in any single volume. On a large map of the world the coal regions

of the globe are well exhibited, and details of those of different countries are presented with singular distinctness on the special maps for the purpose. As an example of the thorough plan of the work, we mention the principal topics under the head Great Britain :—Area of Great Britain—Population—Money, Weights, Measures—Coal-fields, and their influence on her prosperity—Annual production of Coal—General Shipments from the places of production—Table of amount conveyed to London—Source of the same, from 1832 to 1845—average prices—British import and export duties on coals—Effect of the Remission of the British Tariff duties on Coal in 1845—General Exportation—Royalties, Tribute, Rent or Galeage in the English Coal-fields—Mining Leases in Newcastle Coalfield—Area, &c. of 51 Coal-fields of Great Britain. Then follows a scientific account of different coal regions, commencing with the Culm or Anthracite formation of Devonshire. To these are added tables showing the exportation of Iron and Steel ; annual production of iron in Great Britain, European states, America, &c. Moreover a map shows to the eye the positions of all the coal regions. The same extensive plan is adopted for other countries, and carried out in a manner for which no one could be better prepared than Mr. Taylor.

4. *Indicis Generum Malacozoorum Primordia*, etc., conscripsit A. N. Herrmannsen, Dr. med. Cassel, 1846, vol. i, pp. 636, 8vo. Vol. ii, 1847. To be completed in about ten numbers of which eight have appeared, five forming the first volume.—This may be regarded as a companion to the Nomenclator Zoologicus of Agassiz. Like that work, it is an alphabetical list of the genera, &c. in conchology ; with etymologies, dates, authorities, and references : but these last are given more fully, and a very extensive synonymy is given under such names as require it. The genera Conus, Oliva, and Cypræa occupy two pages each ; Exogyra occupies a page, Helix eight pages, and Ostrea three pages. In general, however, each page contains from five to ten genera. When a citation is made at second hand, an asterisk is added and a later author cited. This, like the Nomenclator zoologicus, is an indispensable work to all who wish to be acquainted with the present condition of the science, and the extent to which aberrant species have been the types of distinct genera by the older authors. It gives, moreover, the extent of the various families according to the views of the principal authors, citing the genera which are supposed to be included. The genera are printed in a heavy face small or lower-case type, and the authority follows in small capitals, *without a point between*, a plan adopted by Agassiz, Stephens, Curtis, G. R. Gray, Doubleday and others. Amyot and Serville, place no point only when the name is followed by the original authority. If the authority is regarded as a genitive case, the point is improper. The original authority should be in *italic*, after the manner of Agassiz and the English, who have the credit of systematizing these things. S. S. H.

5. *Principles of Zoology, touching the Structure, Development, Distribution and Natural arrangement of the races of Animals, living and extinct, with numerous Illustrations.* For the use of Schools and Colleges. Part I, Comparative Physiology ; by Louis Agassiz and Augustus A. Gould. 216 pp., 12 mo. *Boston*, 1848. Gould, Ken-

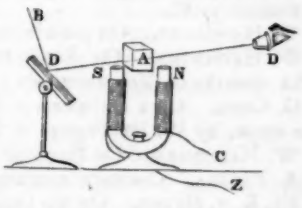
dall and Lincoln.—A work emanating from so high a source as the Principles of Zoology, hardly requires commendation to give it currency. The public have become acquainted with the eminent abilities of Prof. Agassiz through his lectures, and are aware of his vast learning, wide reach of mind, and popular mode of illustrating scientific subjects. In the preparation of this work he has had an able coadjutor in Dr. A. A. Gould, a frequent contributor to the Transactions of the Boston Society of Natural History, and at present engaged upon the Department of Conchology for the publications of the late Exploring Expedition. The volume is prepared for the *student* in zoological science; it is simple and elementary in its style, full in its illustrations, comprehensive in its range, yet well condensed and brought into the narrow compass requisite for the purpose intended. We annex a brief mention of its main topics, deferring a fuller notice to our next number.

Chap. I. The Sphere and fundamental Principles of Zoology.
II. General Properties of Organized Bodies.
III. Functions and Organs of Animal life.
IV. Of Intelligence and Instinct.
V. Of Motion, (apparatus and modes.)
VI. Of Nutrition.
VII. Of the Blood and Circulation.
VIII. Of Respiration.
IX. Of the Secretions.
X. Embryology. (Egg and its Development.)
XI. Peculiar modes of Reproduction.
XII. Metamorphoses of Animals.
XIII. Geographical Distribution of Animals.
XIV. Geological Succession of Animals, or their Distribution in Time.

6. *Observations on the Temple of Serapis at Pozzuoli near Naples;* by CHARLES BABBAGE, 42 pp., 8vo.—This very valuable memoir was read before the Geological Society of London in 1834, but has been withheld from publication by the author, until May of the past year, when it appeared in the Journal of the Geological Society. A full abstract has however been before the public, and the general facts have become a constituent part of most treatises on Geology. The author, after presenting his observations with clearness and philosophical precision, considers next the action of expansion by heat as a cause of change of level: and in conclusion dwells upon the effect which an accumulation of material on the bottom of an ocean would have on changing the position of isothermal lines at depths beneath. If the temperature increase 1° for every 60 feet of descent, an addition of 5000 feet of material will raise as much above its former position, the line of a given temperature below. This accession of heat upward is urged as a means of metamorphic changes, and of various effects of igneous action. The volume closes with a supplement containing "Conjectures concerning the Physical condition of the surface of the moon." The large craters of the moon's surface are compared to Lagoon Islands, when the water of the ocean is removed. Besides other considerations it is an insurmountable objection to the hypothesis, that the lagoons seldom exceed 35 fathoms in depth, and the majority are still shallower. The Southern maldives, among the largest and deepest in the world, have but 60 fathoms of water in the lagoon.

7. ***Elements of Natural Philosophy; being an Experimental Introduction to the Study of the Physical Sciences;*** by GOLDING BIRD, A.M., M.D., F.R.S., F.L.S., &c. &c. With three hundred and seventy-two illustrations. From the revised and enlarged third London edition. 12mo. pp. 402. Philadelphia: Lea & Blanchard. 1848.—The deservedly popular Elements of Natural Philosophy by Dr. Bird, have passed through three editions in London since their first appearance in 1839; and it is an acceptable service that the enterprising American house have performed in renewing the present edition. We observe in the chapters on Polarization, the following notice of Dr. Faraday's researches on diamagnetism, which we copy for the benefit of our readers:—

One of the most interesting contributions to science, for which we are indebted to Dr. Faraday, is the discovery of the excitement of a molecular change in certain forms of glass, water, alcohol, oil, and other substances when under the influence of the magnetic and electric forces, sufficient to cause the rotation of a polarized ray. To show this with the magnet a piece of flint-glass, A, or much better, a heavy slip of fused borate of lead 2 inches square and 0·5 inch-thick, is placed between the poles N S of a powerful electro-magnet, so that the line of force may pass through its length. A ray of light BD is polarized in a vertical plane by reflexion from a piece of blackened glass D, and passing through the glass A is examined at D through a Nichol's prism. So long as the bars N and S are not magnetic, the ray is transmitted or extinguished as usual during the revolution of the prism. Let this be turned so that the ray is darkened, and connect the wires C Z with the battery, the bar instantly becomes magnetic and the ray becomes visible. It will be necessary to revolve the prism to the right to extinguish the ray which has, under the influence of the developed magnetism, been made to revolve. If the north pole be next the observer, the ray will revolve to the right, but if this position be reversed, it will revolve to the left.



When a glass tube is filled with water and placed in the axis of a long helix of wire traversed by a current from a battery of ten pairs of plates, the water assumes a similar rotatory power over a rectilinearly polarized ray, turning it to the right or the left, according to the direction of the current, the ray always revolving in the direction in which the positive current traverses the wire of the helix. When a wide tube of glass is filled with water and the helix traversed by the current immersed in it, the water in the centre of the helix will alone exert any action on a transmitted polarized ray, that lying between the exterior of the coil and the side of the tube having no rotatory power. A piece of borate of lead glass placed in the helix acquires a similar power. Thus by the magnetic and electric forces, Dr. Faraday communicated temporarily to glass the rotatory power naturally possessed by quartz, and to water and other fluids the power proper to syrup and oil of turpentine.

8. *An Introduction to the study of Meteorology;* by DAVID P. THOMSON, M.D. 8vo. Blackwood & Sons, London.—We are informed by a letter dated Wrenbury, Nantwich, March 3, 1848, that Dr. Thomson's Treatise on Meteorology is in press and will soon appear.

9. *Naturwissenschaftliche Abhandlungen*, gesammelt und durch Subscription herausgegeben, von WILHELM HAIDINGER. Erster Band. Subscriptionsjahr vom 1 Juli, 1846, bis 1 Juli, 1847. Pr. 15 fl. C. M. 475 pp., 4to, with 22 plates. Wien (Vienna), Aug., 1847.—This volume of scientific memoirs is published by subscription, the list being headed by his majesty the Emperor of Austria. It is prepared under the able direction of W. Haidinger, well known by his various mineralogical publications, and his English translation of Mohs's Treatise on Mineralogy. It contains the following memoirs.

W. HAIDINGER. On the Pleochroism of Amethyst: p. 1.

F. W. ROSSI. New Species of Arachnida in the K. K. museum. p. 11.

FR. R. v. HAUER. On fossil Cephalopoda from Bleiberg in Carinthia: p. 21.

S. REISSEK. On Endophytes of the cells of plants: p. 31.

H. ST. LOBARZEWSKI. New species of Leafy Musci from the Carpathians: p. 47.

W. HAIDINGER. On pseudomorphs imitative of stone-salt: p. 65.

W. HAIDINGER. On Aspasiolite, as pseudomorphic of Cordierite, with remarks on Metamorphism: p. 79.

G. GÖTH. On a Hailstorm in Steiermark. p. 93; with remarks on the same, by W. Haidinger: p. 96.

W. HAIDINGER. On Hauerite: p. 101.

A. PATERA. Chemical examination of Hauerite: p. 107.

FR. R. v. HAUER. On the Caprina Partschii: p. 109.

V. STREFFLEUR. Phenomena of Ebb and Flow, under the influence of the Rotation: p. 115.

W. HAIDINGER. On the varying colors of faces of Crystals: p. 143.

B. KNER. On the Cephalaspis Lloydii and C. Lewisii of Agassiz: p. 159.

K. PRÜFER. On the Crystalline form of Lazulite:* p. 169.

J. PETZVAL. On the linear Integration of Differential equations: p. 177.

FR. R. v. HAUER. New Cephalopoda from the Sea of Marmora: p. 257.

K. E. HAMMERSCHMIDT. Description of a Species of Oxyuris: p. 279.

J. v. PETTKO. Geological sketch of the District of Kremnitz: p. 289.

A. v. MORLOT. On Dolomite and its relation in origin to Calc spar: p. 305.

F. SIMONY. Meteorological Observations: p. 317.

A. LÖWE. On the Arsenical Nickel of Schladming and Prackendorf: p. 343.

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* The author shows that the form is *oblique* rhombic, and gives fine figures and many measurments.

Fr. R. v. Hauer. On the Fossils of Korod in Siebenbürgen: p. 349.

J. Barrande. On the Brachiopoda of the Silurian Rocks of Bohemia: p. 357—475; with nine crowded quarto plates.

10. *Berichte über die Mittheilungen von Freunden der Naturwissenschaften in Wien.* This Bulletin is from the "Friends of Science" in Vienna, and is published under the direction of M. W. Haidinger. A second volume was issued in 1847, including proceedings from Nov., 1846 to June, 1847.

L. C. Beck: Botany of the United States, new ed. 1 vol. 12 mo. *New York*, 1848.

J. Liebig: Researches on the chemistry of Food, and the motion of the Juices in the Animal Body. Amer. ed. *New York*, 1848. 50 cts.

E. G. Squier and E. H. Davis: Ancient Monuments of the Mississippi Valley, comprising the results of extensive original surveys and explorations; 4to, with numerous elegant illustrations. In the press, *New York*. Published by the Smithsonian Institution.

H. E. Strickland & A. G. Melville: The Natural History and Osteology of the Dodo solitaria, and other extinct birds of the islands Rodriguez, Mauritius, and Bourbon.—In course of Preparation.

Menke and Pfeiffer: Zeitschrift für Malakozoologie, iv. Jahrg. 1847. (12 Nummern) gr. 8. 1 *Thlr.* 15 *sgr.*

E. F. Glocker: Generum et specierum mineralium secundum ordines naturales digestorum Synopsis. 8 maj. cart. *Halle.* 2 *Thlr.* 10 *sgr.*

J. Fournet: Metamorphose der Gesteine, nachgeweisen in den westlichen Alpen; 1 taf., gr. 8. *Freiberg.* ⅔ *Thlr.*

C. F. Rammelsberg: Drittes Supplement zu dem Handwörterbuch der chem. Th. der Mineralogie. *Freiberg.* 1 *Thlr.*

C. Freisleben: Von vorkommen der Silbererze in Sachsen. *Freiberg.* 2 *Thlr.* Also die Sachs· Erzgänge in localer u. Systemat. Reihenfolge, 3 hefte 2 *Thlr.* 15 *gr.* Von vorkommen der Gold und Quecksilbererze in Sachsen. 24 *gr.*

B. Cotta: Geognost Karte von Thuringen. Secs. 2 and 3, imp. fol., 15*s.* 6*d.*; Secs. 1–3, 24*s.* 6*d.*

L. Gmelin: Handbuch der Chemie, 4th edit., 8vo.

Millon: Elemens de Chimie organique, comprenant les applications de cette science à la physiologie animale; 2 vols., 8vo. 15*s.*

Ronquainal: Le globe terrestre reconnu vivant ou physiologie de la terre. 8vo. 3*s.* 6*d.*

W. Sartorius von Waltershausen: Physich.-geograph. Skizze von Island, mit besond. Rücksicht auf vulkan. Erscheinungen. 8vo. 2*s.* 6*d.*

F. G. W. Struve: Etudes d'Astronomie stellaire; la voie lactée sur la distance des étoiles fixes. 8vo. 4*s.*

J. Pelouze & E. Fremy.—Cours de chimie générale, with an atlas of 46 plates. *Paris*, 1848.

Ouvrages sur le Bresil.

Spix and von Martius: Reise in Brasilien, in den Jahren 1817–1820, with an atlas of 40 plates of views, and 8 charts, besides two sheets of music. 3 vols., 1388 pp., and an additional volume on Geography, 40 pp.; 1823–1831. Edition Velin Imperial in fol., 285 *frs.*; in 4to, 216 *frs.*

Martius: Die Physiognomie des Pflanzenreiches in Brasilien. 1824. 2 *frs.*

———: Die Thiere und Pflanzen des tropischen America. 1837. 9 *frs.*

———: Von dem Rechtstande unter den Urein wohnern Brasiliens. 1832, 4to, with an ethnographic chart. 7 *frs.*

Partie Zoologique.—*J. Wagler* and *J. B. de Spix:* Serpentum brasiliensium species novæ, &c., in small folio, new edition of plates, 1838–1840. 108 *frs.*

Avium species novæ, &c.; 2 vols. in small folio; i, pp. 90, 104 col. plates; ii, pp. 85, 118 plates; 568 *frs.*

J. B. de Spix: Species novæ Lacertarum; in small folio, 26 pp. and 28 colored plates. 76 *frs.*

J. B. de Spix: Species novæ Testudinum et Ranarum, &c., folio, 53 pp., with 39 colored plates. 98 *frs.*

J. B. de Spix, L. Agassiz and *C. F. P. de Martius*: Selecta genera et species Piscium, &c., in small folio, 138 pp., 96 colored plates. 1827. 249 *frs.*

Spix, Wagner, Schrank and *von Martius*: Testacea, &c., in small folio, 36 pp., 29 colored plates. 1827. 54 *frs.*

Perty and von Martius: Delectus Animalium articulatorum, &c., in small folio, pp. 224, 40 colored plates. 1830–1834. 164 *frs.*

PARTIE BOTANIQUE.—*Von Martius*: Nova genera et species plantarum, &c., 3 vols. in small folio, with 300 colored plates. 798 *frs.*

Von Martius: Icones Plantarum Cryptogamicarum, 1 vol. in small folio, 138 pp. and 76 colored plates. 1827–1834. 249 *frs.*

———: Specimen Materiæ Medicæ Brasiliensis. Specimen I. Emetica; in 4to, with 9 plates. 1824. Pr. 7 *frs.*

Unger and *Mohl*: Palmarum genera et species, &c. 1823–1845. 220 plates. 1164 *frs.*

Von Martius: Flora Brasiliensis, sive enumeratio plantarum, &c. Fasciculi i–ix, 281 *frs.*

———: Systema Materiæ Medicæ Vegetabilis brasiliensis, 1843. 8vo. 4 *frs.*

Proc. Acad. Nat. Sci. Philad., iv, No. 2; Ap. 11, 1848. p. 36. Habits of some African Reptilia; *T. S. Savage.*—Ap. 25. p. 40. Generation of the Virginian Opossum; *J. Bachman.*—p. 47. A new genus and species of Fossil Ruminantoid Pachydermata (Merycoilodon Culbertsonii), with a plate; *J. Leidy.*

Proc. Amer. Phil. Soc., Philad., vol. v, No. 40.—April 7, 1848, p. 51. A letter on Neptune; *Prof. Peirce.*—p. 16. On the projection of a star during occultation upon the disk of the moon; *S. S. Haldeman.*—April 21, p. 20. Excess of male births diminished by cholera; *Dr. Emerson.*—p. 20. Ephemeris of Neptune; *S. C. Walker.*

Mem. of the Soc. Geol. de France, 2d Ser., Tome II.—First and second parts. On the cretaceous formation southwest, north, and northwest of the central plateau of France (with 3 folded plates of views and sections; *D'Archiac.*—Geological position of the *Macigno* deposits in Italy and southern France; *L. Pilla.*—Observations on the Etrurian formation (with 1 plate); *L. Pilla.*—Geology of the vicinity of Bayonne; *S. P. Pratt.*—Fossils from the Nummuline beds of Bayonne (with 5 plates); *D'Archiac.*—On the geological constitution of the Sancerrois, or northern part of the department of Cher (with 2 plates); *V. Raulin.*—Age of the freshwater formation of the eastern part of the basin of the Gironde (with 1 folded plate of sections); *J. Delbos.*—On the fossils of Tourtia (with 13 plates); *D'Archiac.*

Ann. des Sci. Nat. Paris. OCTOBER, 1847. Arvicola nivalis; *C. Martins.*—Fossil mammalia of Southern France; *P. Gervais.*—Fossil mammalia of Montpelier; *P. Gervais* and *Marcel de Serres.*—Organization of the Genus Galeodes, a type among the Arachnida; *E. Blanchard.*—Connection between the pigment of the hair and of the iris and the faculty of hearing in certain animals; *Dr. Sichel.*—On the Brachiopoda; *A. d'Orbigny.*—On the Gutta Percha and the plant yielding it; 193.—Eight species of Allium, mostly Algerian; *J. Gay.*—New plants from Bolivia; *J. Reney.*—Cellulose, is it the basis of all vegetable membranes; *H. Mohl.*—NOVEMBER, 1847. On the Brachiopoda (continued); *A. d'Orbigny.*—Organization of the Vermes (continued); *E. Blanchard.*—On Cellulose (continued); *H. Mohl.*—On the origin of adventitious buds; *A. Trécul.*—On the pith of ligneous plants; *A. Guillard.*

Archiv für Naturgeschichte, *Berlin*, Third Heft, 1847. On the Naiads, &c.; *F. H. Troschel.*—On insect larves; *W. F. Erichson.*—Review of publications on mammalia and birds for the year 1846.—First Heft, 1848. On the process of subdivision in the egg of snails; *F. Müller.*—Natural history of the "Blasenwürmer" (Cysticercus tenuicollis, etc.); *R. Leuckart.*—Two new species of Helminthes; *R. Leuckart.*—On peculiar air canals in the Velella and Porpita; *A. Krohn.*—New Annelida; *E. Grube.*—Orchestia Euchorus and Gryphus, new species from the Baltic; *F. Müller.*—On the mode of increase in the Chlorogonium euchlorum, Ehr.; *J. F. Weisse.*—On the species of Ctenomys; *A. Wagner.*—Letter on an original figure of the Didus ineptus of Roland Savery, in the Gemälde-Gallerie in the Belvidere at Vienna; *L. J. Fitzinger.*—On the Buds of Upper California; by *W. Gambel*, with remarks by *J. Cabanis.*